AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 18, NO. 25. WEEKLY. | NEW YORK, THURSDAY, JUNE 20, 1895. | $3.00 per Annum. SINGLE COPIES 6 CENTS.

COPYRIGHT 1895, BY AMERICAN MACHINIST PUBLISHING COMPANY. For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Cutting Bevel Gears in a Universal Milling Machine.

BY JARNO.

Bevel gears connect shafts whose axes meet when sufficiently prolonged. The teeth of bevel gears are formed about the frustums of cones whose apexes are at the same point where the shafts meet. In Fig. 1 we have the axes $A\ O$ and $B\ O$, meeting at O, and the apexes of the two cones are also at O. If, in any bevel gear, the teeth were sufficiently prolonged toward the apex, they would become infinitely small; that is, the teeth would all end in a point or vanish at O. We can also consider a bevel gear as beginning at the apex and becoming larger and larger as we go away from the apex.

Fig. 2 is a section of a pair of bevel gears, the gear $C\ D$ being twice as large as $C\ I$. The outer surface of a tooth $J\ E$, Fig. 2, is called its face. The distance $C\ c$ is called the length of the face of tooth, which is often designated by the letter F; strictly, the distance $J\ E$ is longer than $C\ c$, but the difference is not usually recognized. The outer part of a tooth at C is called its large end, and the inner part c the small end. In speaking of the pitch of bevel gears we always name that at the large end or at the large pitch circle, thus the pitch of a bevel gear, at its large pitch circle, corresponds to that of a spur gear. The sizes of the teeth at the small end are in the same proportion to those at the large end as the distance $O\ c$ is to the apex distance $O\ C$, that is, we can figure the sizes the same as we would figure the thickness of a wedge at any point, after we know the length and the thickness at the butt end. There are convenient tables for spur gear teeth in Brown & Sharpe's "Practical Treatise on Gearing."

Nothing is gained by having the length of face $J\ E$ longer than five times the tooth thickness at the large pitch circle, and even this is too long when it is more than a third of the apex distance $C\ O$. To cut a bevel gear with a rotary cutter, as in Fig. 3, is at best but a compromise, because the teeth change pitch from end to end, so that the cutter, being of the right shape for the large ends of the teeth, cannot be right for the small ends, and the variation is too great when the length of face is longer than a third of the apex distance. Frequently the teeth have to be rounded over at the small ends by filing; the longer the face the more we have to file.

The data for bevel gears can be figured by trigonometry, and without a drawing, as in Brown & Sharpe's "Formulas in Gearing;" they can also be obtained by the help of measurements of a drawing. We will suppose that we have a drawing, and that we have the gear blanks turned correctly enough to gauge from in making our settings for cutting the teeth. It is possible to cut a good gear from a blank somewhat incorrectly turned, but it is quite inconvenient to make the settings without guiding by the blank.

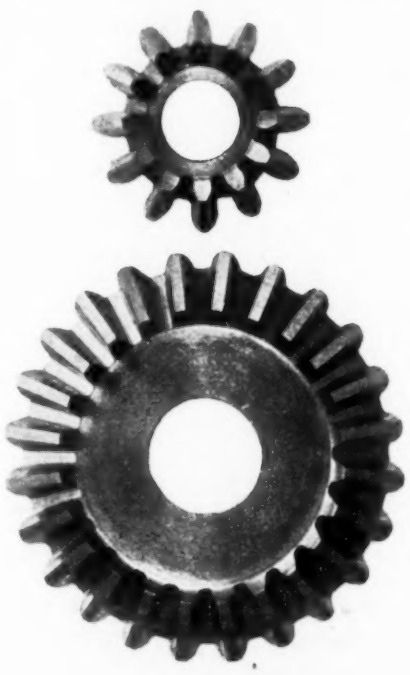


Fig. 1

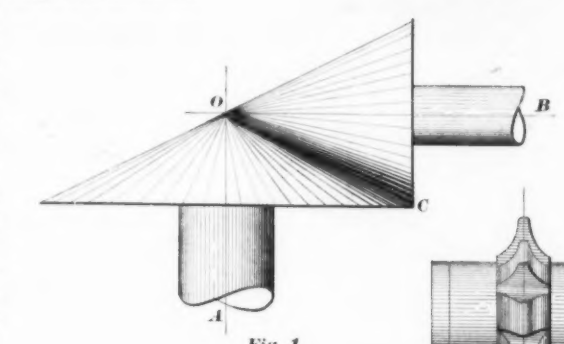


Fig. 2

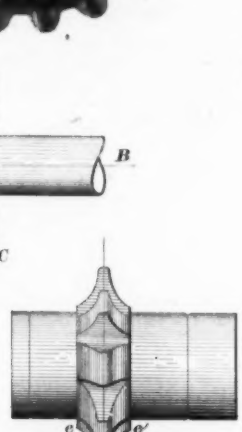


Fig. 3

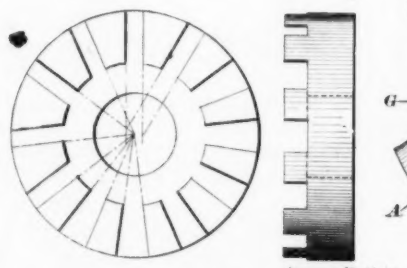


Fig. 5

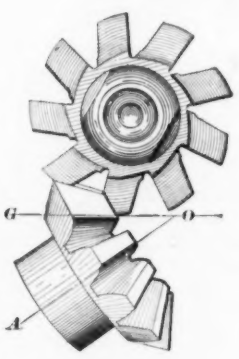


Fig. 4

These data are needed before beginning to cut:

The pitch and the number of teeth, the same as for spur gears.

The number of the cutter, so as to select one of correct form. Brown & Sharpe have a system of eight cutters for each pitch. A pair of bevel gears having different numbers of teeth may require two cutters.

The whole depth of the tooth spaces both at the outer and inner ends, which can be designated by $D''' + f$ at the outer end, and by $D''' + f$ at the inner end.

The thickness of the teeth at the outer and inner pitch lines, which we will designate by t at the outer, and by t' at the inner end.

The hights of the teeth above the two pitch lines, s at the outer and s' at the inner.

The cutting angles, or the angles that the path of the cutter makes with the axes of the gears. In Fig. 2 the cutting angle for the gear $C\ D$ is $A\ O\ G$, and the cutting angle for the pinion is $B\ O\ H$. In Fig. 4 a cutter is shown passing through a tooth space along the line $O\ G$, the gear being set to the cutting angle $A\ O\ G$.

The lines $G\ O$ and $H\ O$, Fig. 2, are called working depth lines, because they show the depth that the teeth of the two gears engage. The spaces are cut deeper than these lines an amount which is called the clearance or f; this f or clearance is the same at both ends of the teeth, when cut with a rotary cutter.

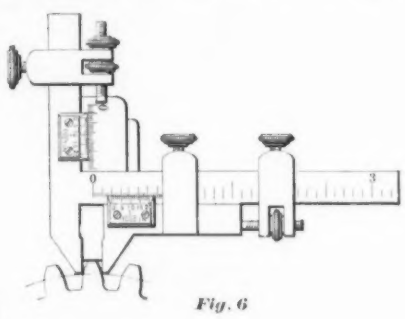


Fig. 6

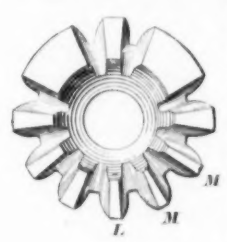


Fig. 7

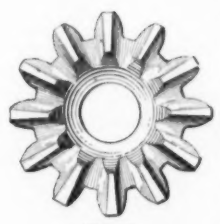


Fig. 9

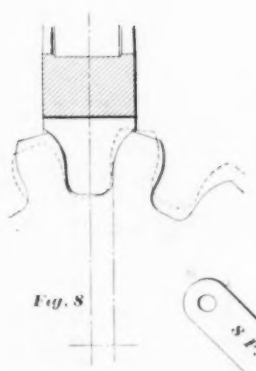


Fig. 8

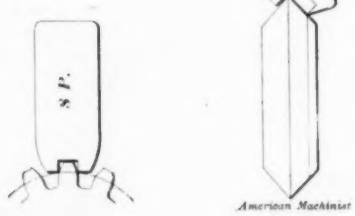


Fig. 13

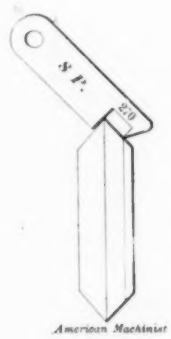


Fig. 12

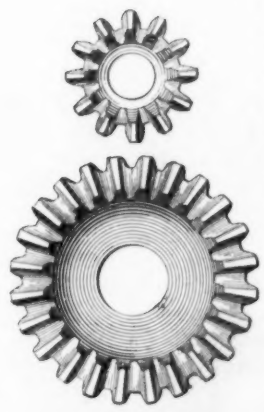


Fig. 10

Brown & Sharpe have kindly offered to turn up a pair of blanks and cut them, while I note down the machine settings. I choose gears of 8 pitch, 24 and 12 teeth, ½ inch face, shown in Figs. 2 and 10.

The shape of the teeth of one of these gears differs so much from that in the other gear that two cutters are required. The cutters may be determined as follows: Twice the length of the line $C\ K$ (Fig. 2) in inches, perpendicular to $C\ O$, multiplied by the diametral pitch, equals the number of teeth for which to select a cutter, as to form, to cut the twelve-tooth gear. This number is about 13, indicating a No. 8 cutter. In the same way, multiplying twice the corresponding line in the other gear by the diametral pitch, we have about 54, calling for a No. 3 cutter. $C\ K$ is sometimes called the back cone radius.

This way of selecting cutters is based upon the idea of shaping the teeth as near right at the large end as practicable, and then to file the small ends where the cutter has not rounded them over enough. In Fig. 7 the tooth L has been cut to thickness at both pitch lines, but it must still be rounded at the inner end, or at the part corresponding to J in Fig. 2. The teeth $M\ M$, Fig. 7, have been filed. In thus rounding the teeth we must avoid making them any thinner at the pitch line.

In cutting a bevel gear the finished spaces are not always of the same form as the cutter might be expected to make, because of the changes in the position of the gear blank in order to cut the two sides of the spaces. The cutter, of course, being thin enough for the small end of a space, the large end of a space is cut to the required width by rotating the blank and adjusting sidewise, and we usually cut twice through each space. Thus in Fig. 3 a gear is in position to have a space widened at the large end e, and the last chip to be taken off the tooth on the right of the cutter, the blank having been moved to the right and then rotated in the direction of the arrow. It may be well to remember that in setting to finish the side of a tooth the gear blank is moved sidewise in the

CUTTING BEVEL GEARS ON THE UNIVERSAL MILLING MACHINE.

direction to take this tooth away from the cutter, and then the blank is rotated by indexing the spindle to bring the tooth up against the cutter. Now this tends not only to cut the space wider at the largest pitch circle, but also to cut still more off at the face of the tooth; that is, the teeth may be cut rather thin at the face, and left rather thick at the roots. This tendency is greater as a cutting angle *B O H*, Fig. 2, is smaller or as a bevel gear is more like a spur gear, because when the cutting angle is small the blank must be rotated through a greater arc in order to set to cut the right tooth thickness at the outer pitch circle. This can be understood by Figs. 5 and 8; in Fig. 5 the teeth are cut square across the axis, and the rotation of the blank in order to cut spaces wider at the outside has not narrowed the faces of the teeth any more than the roots. The different positions of the cutter in both the unfinished and finished spaces is shown by the dotted lines. Now as the cutting angle of a bevel gear approaches a right angle, as in Fig. 5, we find less and less tendency to cut the tooth faces too narrow. In Fig. 8 a cutter is passing through a space in a spur gear, which has no cutting angle; it is clear that any rotation of this blank tends directly to change the shape of the teeth as regards the thickness of the face and the root. In this particular setting, shown by the center lines of the cutter and of the gear, the roots are not changed while the faces are made considerably thinner, as indicated by the dotted lines. This change in the shape of the spaces caused by the rotation of the blank may be so great as to require the substitution of a cutter that is narrower at *e e'*, Fig. 8, that is, a cutter for cutting a higher-numbered gear. In using the cutter for a higher-numbered gear the radius of curvature of the tooth sides is lengthened, but the longer tooth curves are not so objectionable as the thin tooth faces.

In the order for cutting the gears, Fig. 10, the foreman of the gear department calls for a No. 6 cutter for 17 to 20 teeth to cut the 12-tooth gear, instead of a No. 8, as I have just figured. This is a little surprising, but it is still more surprising to be told by the foreman of the cutter department that he would fill an order for a cutter to cut this same gear by sending a No. 8 for 12 to 13 teeth. I told him about the gear order, and he replied, "I don't know what they do over there, but I should think they work by guess. I make cutters according to the rule in the catalog. If there is a better rule I should like to have it. We seldom or never have any fault found with bevel gear cutters because they round the teeth over too much, but we have had complaints because the teeth are not rounded enough."

From this it might be supposed that Brown & Sharpe would use one thing on their own work, and send their customer another, but such a supposition would not be fully warranted. As I have said, the cutting of a bevel gear with a rotary cutter, as in Fig. 3, is a compromise. The necessity for a compromise is evident when we consider that an 8-pitch gear at one end may run down to 12 pitch at the other.

Different workmen prefer to compromise in different ways. A workman can avoid much filing of the teeth by the use of the No. 8 cutter, but the tooth faces will be considerably too thin at the large ends. He can also avoid some filing by an extra cut upon each side of the teeth at the small ends, making four cuts in all. I have known this compromise with a coarse pitch and long face. If the faces are short and the pitch is fine he can sink the cutter below the regular depth at the outside, and cut only once around; this compromise is little liked, and is seldom employed; it may require a special form and thickness of cutter. The best compromise is to cut twice around, shaping the teeth as nearly correct as practicable at the large ends, and then file the small ends in low-numbered gears, or those of fewer than twenty teeth. A workman can soon acquire the skill to file the teeth almost as perfect as they can be planed from a template. Still most workmen prefer not to file the 12-tooth gear, Fig. 2, which is the reason why the rule in the catalog is followed in filling an order for a gear cutter.

In the selection of a cutter, the foreman of the cutting department tells me that he cannot give a definite rule, and that he is open to the criticism of guessing. If a pinion of only 12 teeth is to run with a gear two or more times as large, he takes a cutter shaped for 17 to 20 teeth, instead of the usual 12 to 13 teeth. For any gears higher than 25 teeth he would adhere to the rule, and take the cutter indicated by the length of the line *C K*, Fig. 2. If he has many gears of the same size, he cuts one pair and files them to run together, in order to decide definitely as to the cutters.

The sizes of the tooth parts at the large end are copied right from a table of spur gear teeth. The distance *O c*, Fig. 2, is seven-tenths the apex distance *O C*, so that the sizes of the tooth parts at the small end, all except *f*, or the clearance, are seven-tenths the large. The order goes to the workman in this form, *P* standing for diametral pitch, and *N* for the number of teeth:

LARGE GEAR.

$P = 8$
$N = 24$
$D'' + f = .270''$ $D''' + f = .195''$
$t = .196''$ $t' = .137''$
$s = .125''$ $s' = .087''$
Cutting angle = 59° 10'.

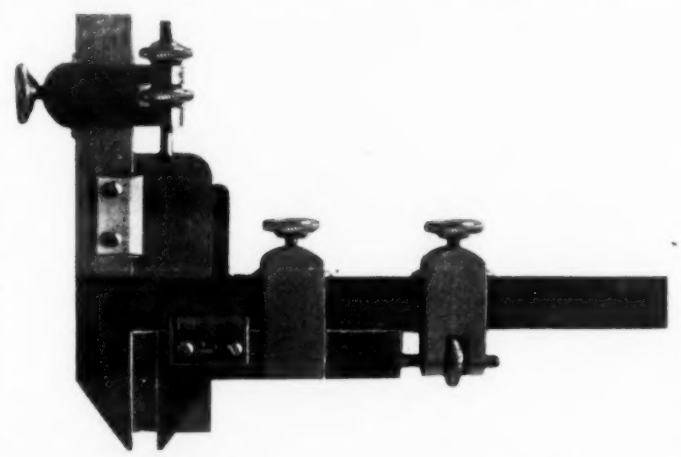
SMALL GEAR.

$N = 12$.
Cutting angle = 22° 18'.
Cutters, Nos. 3 and 6, 8 *P*, bevel.

Before beginning to cut, the bed *S*, Fig. 11, is set to zero. The dial pointer of the cross-feed screw *T* is set and noted, so that we can adjust the blank to any required distance out of center with the cutter. The spiral head *N* is moved up to the cutting angle, which for our 24-tooth gear is 59° 10'; we guess at the ½ degree more than 59 degrees.

Mark the depth of cut at the outside, as in Fig. 12; it is also well enough to mark the depth at the inside, as a check. The thickness of the teeth at the outside is conveniently determined by the solid gauge, Fig. 13. The vernier caliper, Fig. 6, will measure different sizes. If we do not have the vernier caliper, a gauge like Fig. 13, filed to the thickness at the small ends, will answer.

The index having been set to divide to the right number, our workman cuts two spaces central with the blank, leaving a tooth between that is a little too thick, as in the upper part of Fig. 7. The tooth has to be cut away more in proportion from the large than from the small end, which is the reason for setting the blank out of center, as in Fig. 3.



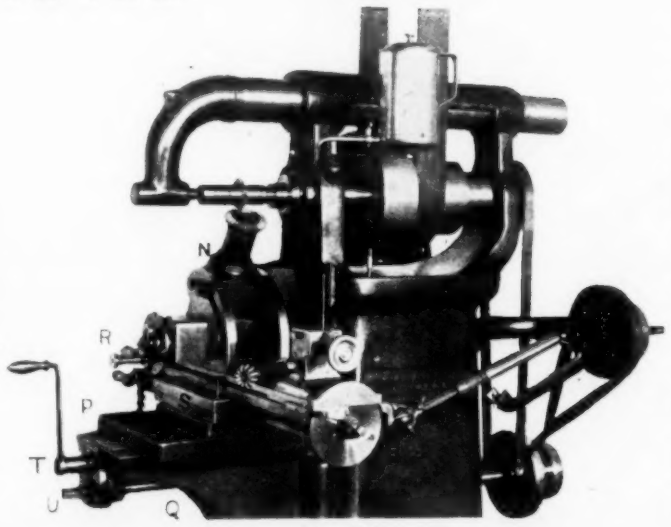


Fig. 11.

CUTTING BEVEL GEARS.

It is important to remember that the part of the cutter that is finishing one side of a tooth at the pitch line should be central with the gear blank, in order to know at once in which direction to set the blank out of center. We cannot readily tell how much out of center to set the blank until we have cut and tried, because the same part of a cutter does not cut to the pitch line at both ends of the tooth. As a trial distance out of center, we can take about one-tenth to one-eighth of the thickness of the teeth at the large end. The actual distance out of center for the 12-tooth gear is .021 inch, and for the 24-tooth .030 inch, when using the cutters listed in the catalog.

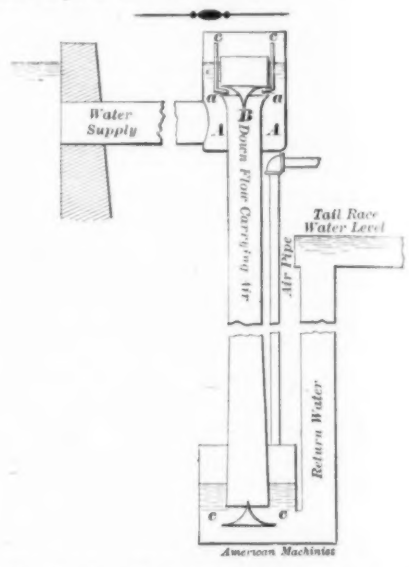
After a little practice a workman can set his blank the trial distance out of center, and take his first cuts, without making any central cuts at all, but it is safer to take central cuts like the upper ones in Fig. 7. The depth of the cuts is controlled by the shaft *U*, Fig. 11. Now, by means of the screw *T*, set out of center the trial distance, which can be one-tenth the thickness of the tooth at the large end in a 12-tooth gear, and from that to one-eighth the thickness in a 24-tooth gear and larger. The direction out of center is indicated in Fig. 3, which is to move the tooth away from the cutter, by turning the cross-feed screw *T*, Fig. 11; the tooth is then rotated up against the cutter in the direction of the arrow, Fig. 3, by turning the index crank *R*, Fig. 11, just enough to trim the side of the tooth as shown in Fig. 3. The blank is now set the same distance out of center in the other direction, rotated contrary to the arrow, Fig. 3, and the other side of the tooth is trimmed until one end is nearly down to the right thickness. If now the thickness of the small end is in the same proportion to the large end as *O c* is to *O C* in Fig. 2, we can at once trim the tooth to the right thickness by turning the index crank *R*, Fig. 11. The object of setting out of center is to trim more from the large end *e'*, Fig. 3; if now we find that by our two settings the tooth is still going to be too thick at *e'*, when the small end is right, the out of center distance must be increased.

An easy way to remember this principle is this: Too much out of center leaves the small end of the tooth too thick, while too little out of center leaves the small end too thin.

After the proper distance out of center has been learned, the teeth can be finish-cut by going around out of center first on one side, and then on the other, without cutting any central spaces at all. If, however, a gear is coarser than 5-pitch diametral, it is sometimes well enough to cut all the spaces central at first.

Blanks are not always turned nearly enough alike to be cut without a different setting of the machine for different blanks. If the hubs vary in length, the hight of the knee *Q*, Fig. 11, has to be varied. In thus varying, the same depth of cut or the exact $D'' + f$ may not always be reached. A slight difference in the depth is not so objectionable as the incorrect tooth thickness that it may cause, hence it is well, after cutting once around and finishing one side of the teeth, to adjust the spindle *N*, by means of the index crank *R*, until the right tooth thickness is obtained, paying more attention to the tooth thickness than to the number of index spaces covered by the crank. Of course, if the blanks are alike, it is easier to count the index spaces in passing from one side of the tooth to the other.

After a gear is cut and before it is filed it is sometimes not a very satisfactory looking piece of work. In Fig. 7 the tooth *L* is as the cutter left it, and is ready to be filed to the shape of the teeth *M M*.



The Taylor Hydraulic Air-Compressing System.

Our attention has been called to a device, the invention of Mr. C. H. Taylor, of Montreal, for compressing air by the direct action of falling water, without the aid of machinery. We may say of the arrangement that we are of the opinion that it will do all that seems to be claimed for it; that is, that it will compress air, that it will compress it to a pressure corresponding to the depth to which the pipe is carried, and that it will deliver the air drier than it can be delivered by any system of compression that does not deliver the air as *cool* as it is delivered by this means. With an unlimited water supply, free of cost, and with a small demand for compressed air at low pressure, this might be the proper device to employ. A sketch is appended from which the operation of the apparatus will be understood. The water from any available source is conveyed to a chamber *A* at the head of a vertical pipe *B*. This pipe may extend downward to any depth, this depth being determined by the pressure to which it is desired to compress the air. The water from the chamber *A* enters the vertical pipe *B* through the annular opening *a* in the enlarged head of the pipe. Surrounding the head of the pipe are a series of small vertical air tubes *c* with their lower ends or connections extending horizontally or nearly so into the annular opening *a* where the water enters. As the water passes the ends of these air pipes more or less air is drawn in from them and mingles with the water. This air in minutely divided portions is carried down the pipe with the water, and, as the pressure in the column of water increases with the depth, the air is subjected to the pressure of the water in contact with it, and is compressed.

The heat that is generated in the air by its compression is immediately communicated to the water, and as the specific heat of water is so much greater than that of air, being more than 3,000 to 1 for equal volumes of free air and of water, the compression of the air is practically isothermal, while the heating of the water is scarcely perceptible. The water and air emerge from the lower end of the pipe into the chamber *C*.

where the air rises and separates from the water. When the apparatus is in operation the upper portion of the chamber *C* becomes a reservoir of compressed air. This air is conveyed by the small vertical air pipe to the point where it may be required for use. The water passes out of the lower part of the chamber and upward through the return water pipe to the tail race and flows away. The pressure of the compressed air in the chamber is determined not by the column of water in the descending water pipe, but by that of the upward return water pipe. As this pipe contains solid water unmixed with air the pressure upon the air will be that due to the height from the surface of the water in the reservoir to the water level in the tail race, each 27.7 inches of hight giving 1 pound of pressure. It will be near enough for this explanation to say that 2 feet of hight in the water column produces 1 pound of air pressure. Then if it is desired to deliver the air at a pressure of 50 pounds gage, the level of the water in the lower chamber *C* must be 100 feet below the level of the water in the tail race, and whatever air accumulates in the upper part of chamber *C* will always be compressed to this pressure.

The practical question, we are inclined to say the fatal question, concerning this apparatus, is as to the volume of air that can be compressed by it. It is to be noted that the flow of the column of water will be comparatively slow, much slower than that of water falling freely, and on account of its slowness of movement it cannot be assumed to draw in the air through the little air pipes *c c c* very rapidly. Then the volume of air under compression at any given time, or the volume of air compared with the total volume of water in the descending column, must be necessarily small. To whatever depth the compressing column may be carried, all the movement of the contents of the descending and returning columns must be due to the excess of weight in the descending column over that in the returning column.

If both of the water pipes, the descending or compressing pipe, and the return or water discharge pipe, were filled with solid water up to the level of the tail race (as we know the return pipe is so filled), and if all of the upper part of the down flow pipe were filled with air, from the level of the tail race upward, there would be no flow of water in the pipes. To produce any movement of the column there must be an excess of weight in the descending column, and to maintain a flow at a practical speed, overcoming the friction of the entire series of pipes, and also that of the air itself in the water, as it will be constantly struggling upward through the water in which it is entangled, the excess of weight in the descending column must be quite considerable. It is probable that at no time will the total air in the descending column exceed one-half of the volume of that portion of the descending pipe above the level of the tail race. This air will not at any time be concentrated in that upper portion of the pipe, but will be distributed throughout the pipe, which will not affect the effective weight of the whole. It will not be practicable to use this apparatus except for comparatively low pressures of air. The common working pressure for rock drills and general use in motors is from 70 to 80 pounds, gage, which would require a depth of about 150 feet below the level of the tail race, and the constant struggling ascent of the air through the descending column of water would result in a very slow delivery of the compressed air into the chamber at the bottom. The description of this apparatus which has been published seems to assume that air may be compressed by it for charging street railroad motors. As the reservoirs of these motors are, or should be, charged up to from 500 to 1,000 pounds, it would, of course, be impossible to do it by this means.

In the saw mill the circular saw has of late years been doing much of the work that a generation ago was done almost exclusively by gang saws. The band saw is now rapidly driving out the circular saw. It is estimated that in 1894 fully 50 per cent. of the total output of white pine lumber in Michigan, Wisconsin and Minnesota was cut by the band saw. The saving in the product is said to be about 6 per cent. over the circular saw, or the band saws in use in 1894 saved $2,000,000 in value of lumber. We imagine also that it is a safer thing to have around. A large part of the work of the machinist in these latter days is in the making of machinery to be substituted for other machinery that has been superseded in the advance of methods. Another notable instance of this operation is in the flour mill. The inventor continually makes work for the machinist.

Some Thoughts on Machine Design—II.

BY PROF. DE VOLSON WOOD.

Having now learned something of the state of the art and science in regard to the thickness of cylinders, we return to the further consideration of the steam cylinder. Flanges are cast on each end of the cylinder to make a seat for the "cover" or "head," and for holding the bolts for securing the "cover." For the latter purpose, lugs cast on the cylinder would answer every purpose; but formerly the entire surface between the "cover" and flange was packed with rubber cloth or other gasket to make a steam-tight joint, in which case it was desirable to use a flange instead of lugs, so as to form a broad seat for the packing.

It would make the pattern more costly to put on "lugs" than to make a continuous flange. If the cover be circular, as usual, it looks better to have a flange of the same

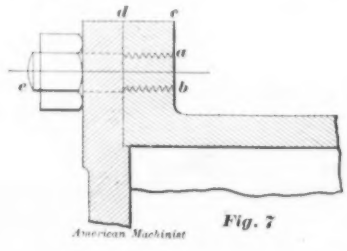


Fig. 7

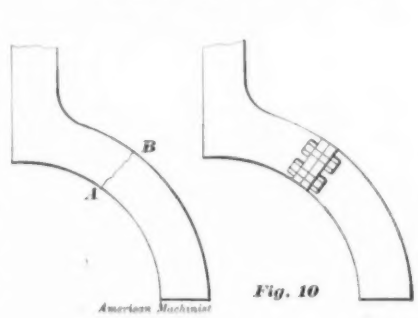
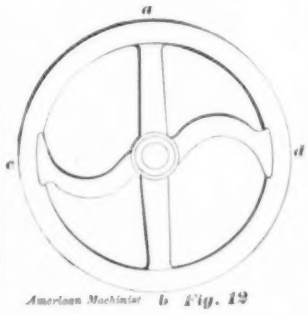


Fig. 10

Fig. 11



b Fig. 12

MACHINE DESIGN.

form and size. Certain special engines may require cylinder heads of irregular form, and the designer should be free to adapt himself to circumstances.

The width of the flange *b e*, Fig. 1, will depend partly upon the size of the bolts. The inside line *e b* of the bolt should be outside the line of the cylinder so that the boring tool and tap may pass through freely. The proper size of the bolts will depend upon their number, or the number upon their size. The minimum size will be such that they will not be liable to break in the process of manufacture, say, ½ inch for very small engines, ⅝ inch for ordinary sized cylinders of 6, 8 or 10 inches bore.

Example.—If diameter of cylinder be 10 inches, diameter of bolts ⅝ of an inch, steam pressure 100 pounds, how many bolts should be used to secure the cover?

The cross section of the bolt will be $0.7854 \times (\frac{5}{8})^2 = \frac{5}{16}$ of an inch nearly, but as the thread will reduce the effective area somewhat, call it ¼ of an inch. Good iron will stand a pull of 50,000 to 60,000 pounds per square inch, but for safety call it 10,000, and since the bolts will be subjected to an initial tension due to screwing up the nuts, which amount cannot be easily computed, so we will call the remaining strength 6,000 pounds, and each bolt will stand ¼ of 6,000 = 1,500 pounds. The area of the cross section of the cylinder will be 0.7854×10^2 = 78.54 square inches, and hence the pressure will be $78.54 \times 100 = 7{,}854$ pounds, and the number of the bolts should be $7{,}854 \div 1{,}500 = 5$ bolts. But in practice 8 or 10 such bolts would be used so as to give a more uniform bearing of the cover on its seat. It will thus be seen that with the size bolts ordinarily used and the number of them, that their strength is more than sufficient to prevent their being "blown" off at any ordinary working pressure.

The width *a c*, Fig. 7, outside the bolt is subject to the caprice of the designer. It should not be so small as to look stingy, or be liable to break in handling, nor so large as to be wasteful, nor unnecessarily heavy. According to some designers, it should not be less than ¼ of an inch, and need not equal the diameter of the bolt. It should be so wide that the nut will not overhang. An extensive practice shows that stud bolts are most desirable in ordinary engine practice, but there are cases where a through rod *a b*, Fig. 8, securing both heads with one rod is not only preferable, but well-nigh necessary for practical success. Such is the case with the steam rock drill, where the piston is more or less free to strike either or both ends. In this case, if a stud bolt should be broken, it would not be easily repaired, but if a long rod, such as shown in the figure, is

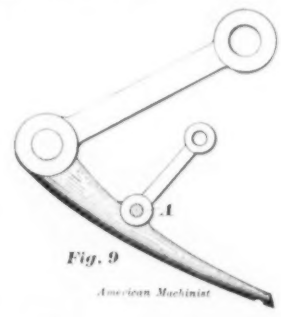


Fig. 9

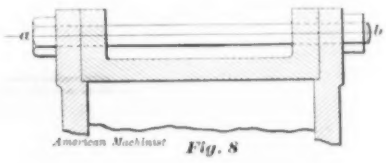


Fig. 8

broken, a blacksmith having his own dies and taps could easily make a rod and insert it. A long rod also is less liable to break than a short one under these conditions. This suggests another principle in designing. In a machine in which some part is quite certain to break, the designer may sometimes select the piece, and perhaps the place where he would have the breakage occur, and then provide for it beforehand. As just intimated, a rock drill is liable to be broken about the heads; so let the heads be very strong and secured by rods more liable to break, and supply duplicate rods. One not having experience with special machines is liable to overlook these points. I once heard a mechanic of high standing who had had a large and varied experience in the shop, criticise the through rods on the rock drill, and advocate the substitution of stud bolts; but he had not had such an experience with those machines as had the inventor.

Again in the use of the grain drill, the spout which conducted the grain to the ground was liable to be caught under a root or stone and the machine be broken. A man secured it at *A* with a wooden pin, which would break first, and so save the machine, the only repair necessary being the insertion of another wooden pin, which the farmer could make with his jack knife. The royalty on this patent brought considerable revenue.

Again, a manufacturer of steam hammers found that the frame broke as at *A B*. Flanges were made heavier on the inside at *A* and outside at *B*, but still it broke at about the same place. The evil was finally remedied by making a joint at *A B* with flanges and bolting the two parts together.

Again, in the use of the steam hammer in which the rod entered the hammer block with a slight conical taper, the rod would break sooner or later, and to cause as little delay as possible a duplicate rod was kept in readiness. On one occasion the rod broke at *A B* just within the block raising a burr, and requiring several hours to remove the broken piece; thereupon the mechanic reduced the diameter at *C D* outside the hammer block to compel it to break at that point.

This simple device unexpectedly prolonged the life of the rod some three times its former life, and finally broke at *C D*, the place provided. The steam hammer, like the rock drill, may break where least expected, but those most likely to occur frequently may be provided for. Again, the file-cutting machine was not made practical until the cause of certain breakages were removed and others provided for. Feeding by the continuous rotation of a screw in place of by intermittent motion with a ratchet was one of these improvements. The practical question often is, not whether all or nearly all breakages can be prevented, but whether it pays to use a machine in which breakages frequently occur.

But returning to our steam cylinder we inquire about the thickness *a d* of the flange, Fig. 7. It should be thick enough so that it will not pull off on account of the pressure against the heads. For instance, if the diameter of the cylinder be 8 inches, the cross-section area will be about 50 square inches, and if the pressure be 150 pounds per square inch the pressure against the head will be about $50 \times 150 = 7{,}500$ pounds. If the breakage should occur at *b* where the flange joins the cylinder, the diameter of the juncture will be about 9 inches, and the circumference about $\pi \times 9 = 28$ inches, and if the strength of the iron be only 1,000 pounds per square inch the strength will be 28,000, and this divided into 7,500 gives less than $\frac{5}{16}$ of an inch, although we have assumed a high pressure and low strength. But no practical mechanic would make a flange so thin for such a cylinder. The thickness must be sufficient to make a satisfactory anchorage for the bolt, and for this purpose the thickness may be about equal to the diameter of the bolt. This will give sufficient strength all around, but some designers considering that cast-iron is cheap, and that a thicker flange gives an appearance of strength, make the flanges thicker than here suggested. It is again largely a matter of judgment of the designer, and of practice in the particular shop.

A sharp angle at *b*, the juncture of the flange with the cylinder, should always be avoided, for in cooling internal stresses are produced, weakening the metal, and sometimes actually producing breakage.

This is especially the case where light parts join heavy parts. Thus in a pulley, if the straight arms join the rim at right angles as at *a* and *b*, the arms being the lightest will cool first, and by contracting pull away from the rim, making a crack at *a* and *b*. To avoid this the arms are sometimes curved and join the rim by a fillet. The curvature of the arms allows them to straighten, if necessary, while cooling and contracting. A breakage may be avoided partly, if not wholly, by cooling the casting slowly, giving all the parts a chance to adjust themselves as cooling goes on. It is advisable, however, to put a fillet, even if it be small, in every angle of a casting.

It seems to be an accepted rule that the velocity of steam in the steam passages may be 100 feet per second without producing appreciable loss from frictional resistances, but this rule would in many cases give such small steam ports and passages that the cores cannot be properly vented. The writer once tried to secure very small passages for a cylinder, but the foundry could not produce

sound castings—blow holes appearing in every one cast. The evil was overcome by making the passages larger and thus securing proper vent for the cores; also by dry sand molds in which the moisture was removed before pouring.

The preceding examples and remarks serve to show that the successful designer must have a variety of knowledge, all of which cannot be expressed in theoretical or even empirical formulæ. There are, however, numerous cases in which theory, or formulæ founded on theory, furnish the best and safest guides in determining proportions, and these may be found in works which treat of the subject. Theory is a correct guide when the data and the laws governing their action are known. Theory is not to be violated but supplemented.

Fire Boat for the City of Boston.

With this we give illustrations of the engine, boilers, and an elevation showing the position of the machinery in a new fire boat, now nearing completion, for the city of Boston.

The engines are of the vertical inverted-cylinder, direct-acting compound type. The high-pressure cylinder is 18 inches diameter, low-pressure 36 inches diameter, and 24 inches stroke. The high-pressure valve is of cast-iron of the piston type; the low-pressure valve is a double-ported slide valve; and both are proportioned for a piston speed of 540 feet per minute.

The valve gear is of the Brown & Miller's patent cut-off type, with double-bar links. Eccentrics and straps of cast-iron, and eccentric rods of wrought-iron fitted with straps, gibs, and keys where attached to the links. Valve stem guides are of cast iron and secured to the cylinders, they are fitted with gibs adjusted with slips. The reversing engine is of Brown & Miller's patent steam reverse type; cylinder 7 inches diameter.

The framing consists of two cast-iron columns on the rear side of the engine, fitted with water slides; and four wrought-iron columns on the front side of the engine.

The bed plate is of the box type, 14 inches deep under the boxes, and fitted with four main bearings. The main boxes are of cast-iron, babbitted; they have no flanges; they are secured by the cap bolts, worked half in the bed and half in the box.

The condenser is of cast-iron, circular in form. Cooling surface, 1,100 square feet; brass tubes tinned inside and out; tube sheets of composition; the cooling surface being commensurate with the power of the boiler. The latter being calculated to supply steam to propelling engine while fire pumps are in operation. The independent air and circulating pump has a steam cylinder 12 inches diameter, air cylinder 14 inches and water cylinder 14 inches diameter, all 12 inches stroke. The circulating and air cylinders are lined with composition.

Piston rods are of mild steel, 3¼ inches diameter. The crossheads are of wrought-iron with journals forged on; the shoes are of cast-iron, babbitted and bolted to crossheads; wearing surface on each 88 square inches. The connecting rods are of steel, 5 feet long between centers; the crank pin bearing is 7¾ inches diameter and 8½ inches long; the crosshead bearings are 4 inches diameter, 4½ inches long. The crosshead boxes are of composition; and the crank pin boxes of composition, babbitted. The crank shaft is of the built-up type; it has four main journals, each 7¾ inches diameter and 8½ inches long; the shafts and pins are of steel, slabs of wrought-iron, coupling forged on shaft. The propeller shaft is of steel 7½ inches diameter, covered from inboard stuffing box to outer end with composition ½ inch thick at bearings.

The propeller is of the built-up type 8 feet diameter, 12 feet pitch. The hub is counterbored to go over the composition sleeve on shaft; it is secured with a longitudinal key, and composition tap bolt in end of shaft, with composition cap.

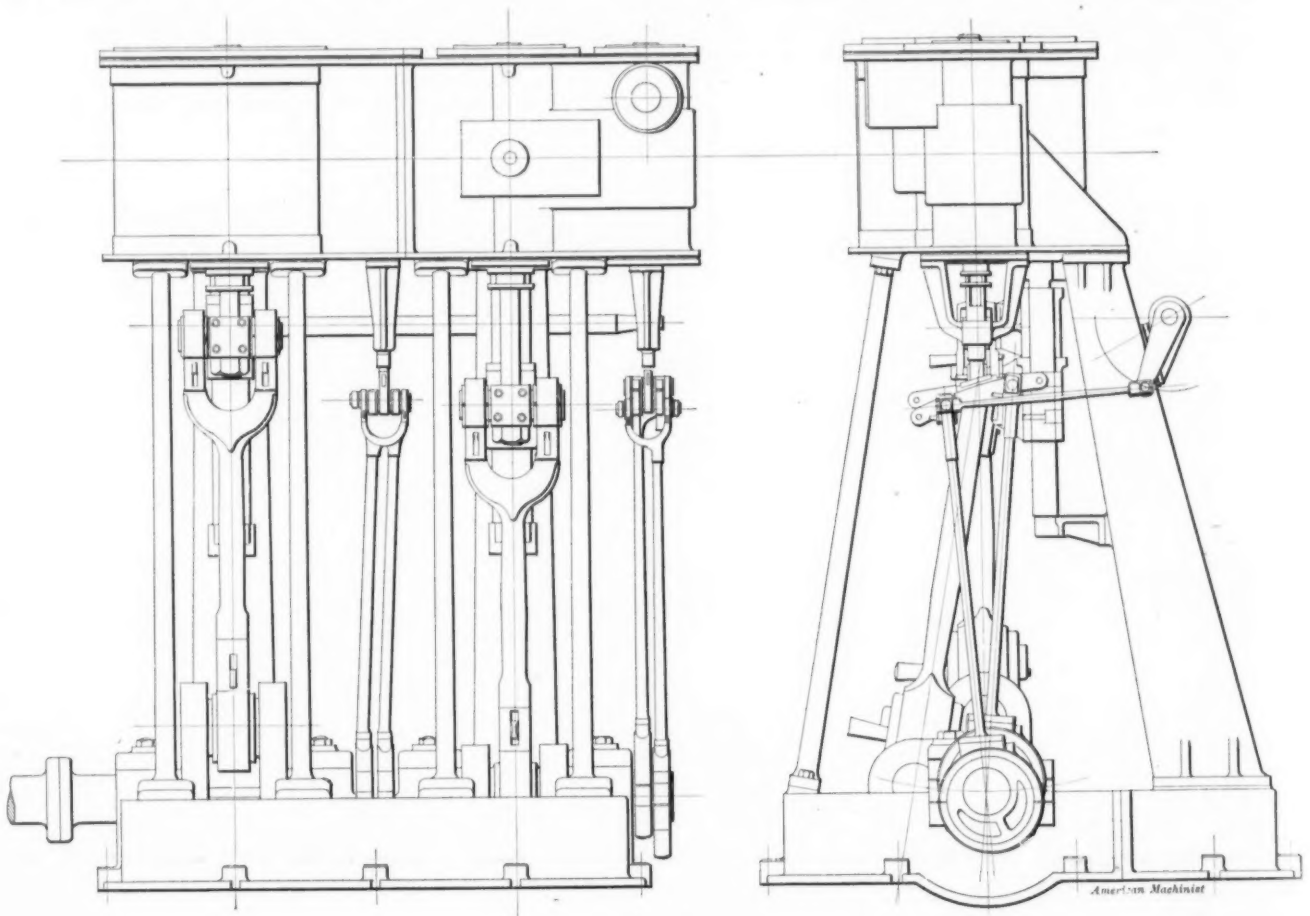
Exhaust pipe of cast-iron 12 inches diameter, with 8-inch valve and pipe for outboard exhaust which projects through the roof and is capped with composition cap. Main steam pipe for engine is of copper 4½ inches diameter, No. 8 B. W. G.

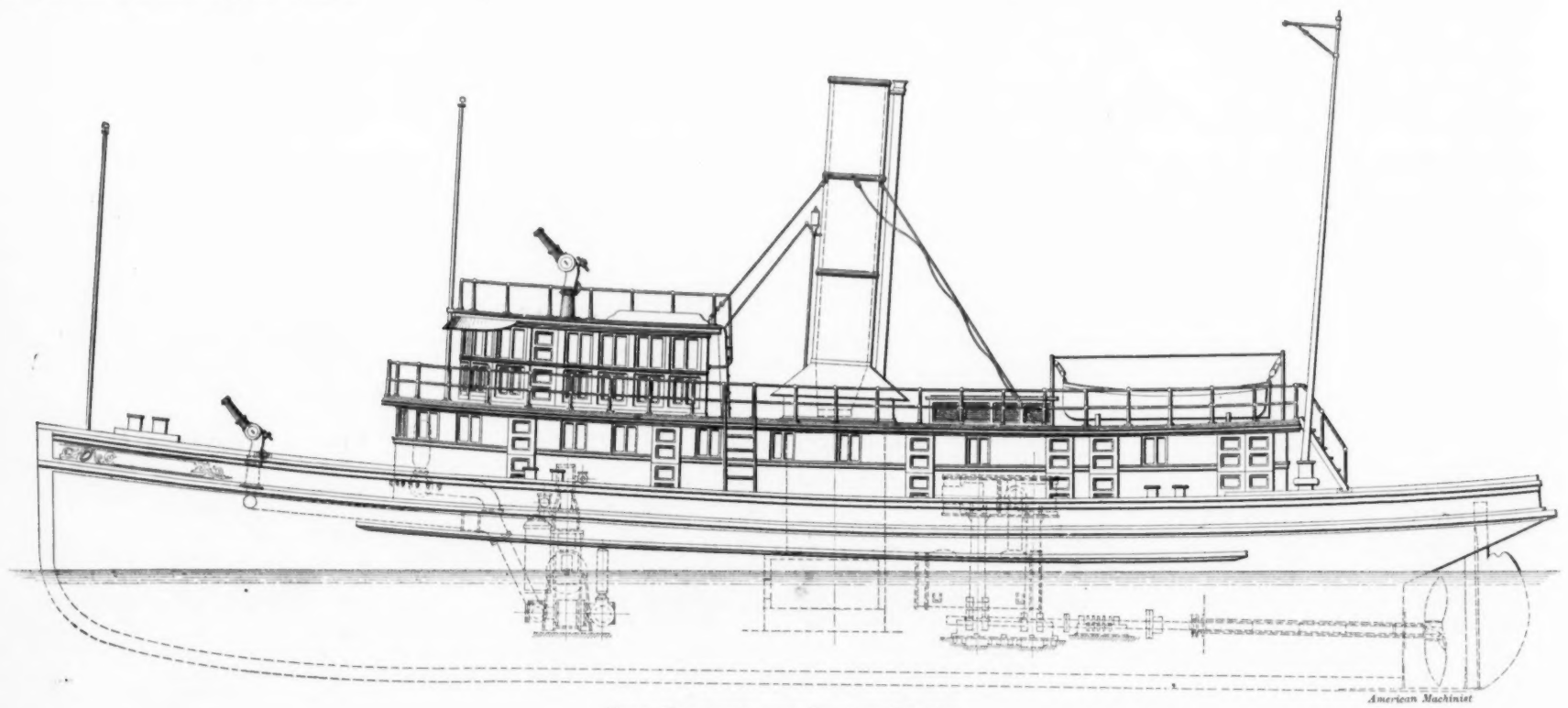
There are two boilers of the type shown, built for a working pressure of 120 pounds per square inch. Thickness of shell, ½ inch; crown sheets, ½ inch; tube sheets, ½ inch; furnace, 11/32 inch; smoke box, 7/16 inch; all of Siemens-Martin steel. Each boiler contains 542 lap-welded iron tubes 5 feet long, 2 inches diameter, expanded and beaded over at both ends, 2½ inches, spaced centers. The smoke pipe is made double 52 inches outside diameter; air space 2½ inches. The inner pipe is made of No. 12 iron, and the outer pipe of No. 14 iron.

There are two vertical fly wheel duplex fire pumps, double acting, furnished by American Fire Engine Co., of Seneca Falls, N. Y., with steam cylinders of the compound type; these cylinders are of cast-iron. The water cylinders are made of composition, 88 parts of copper; tin, 10; and zinc, 2. The valves are large, that of the suction is 80 per cent., and of the discharge 66 per cent. of area of pump cylinder at each end. Each pump is provided with large suction and discharge air chambers, and an arrangement of piping and valves to force air into the chambers.

The suction piping of pumps is common to both, and connected with sea at each side of the vessel. The suction pipe is of copper 16 inches diameter, and has valve at each pump. Sea valves for suction are straight-way valves of composition fastened to hull. Openings through hull are 18 inches in diameter, and are lined with lead ¼ inch thick, turned over and nailed. These openings are covered with composition strainers, the holes in each strainer have an area of 50 per cent. in excess of the 18-inch opening. This piping is so arranged that each pump can be run independently.

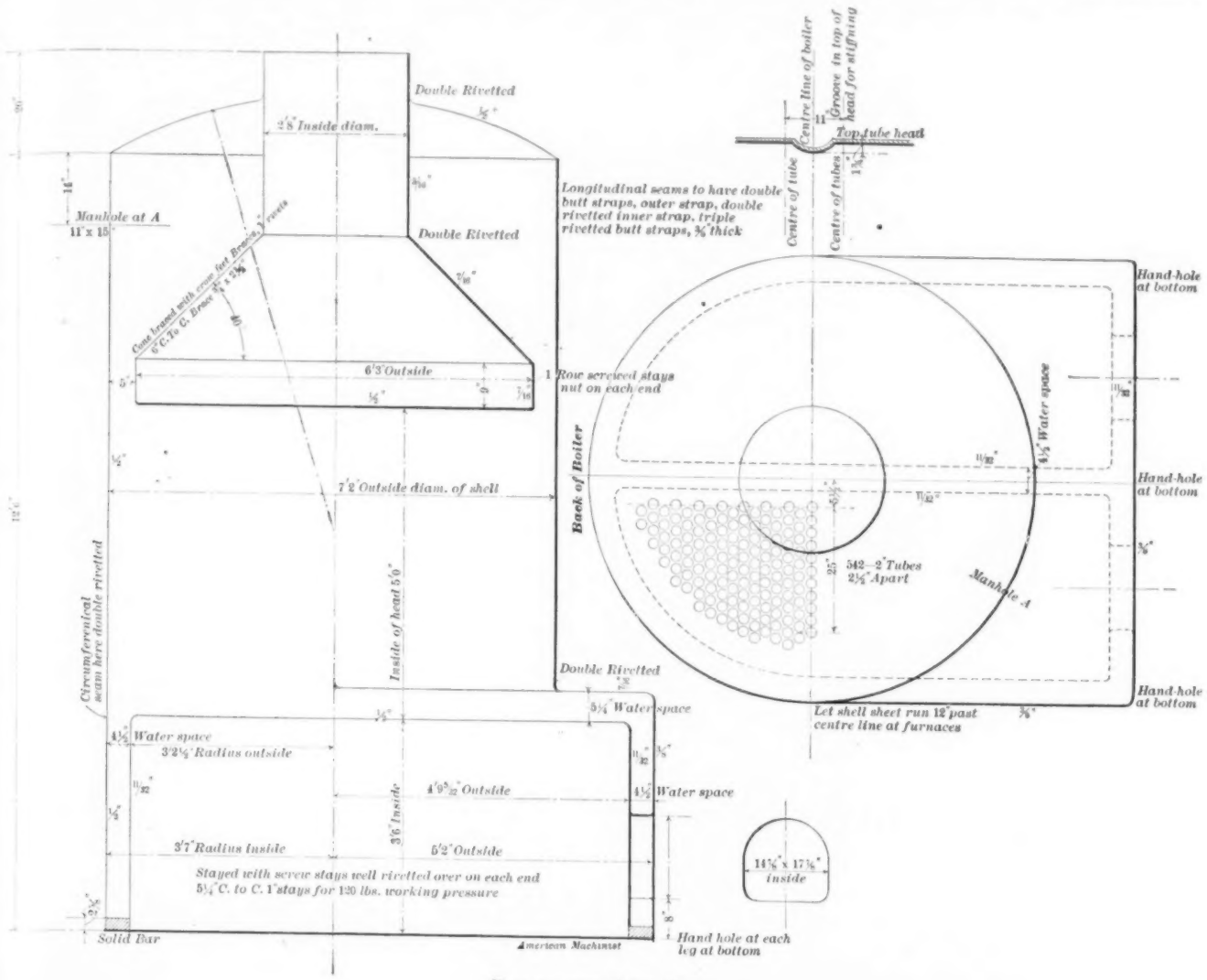
The discharge pipe, with air chambers in deck-house, is made of heavy charcoal iron, 12 inches diameter, 1⅛ inches thick, and is connected to pumps with copper pipes with a valve at each pump. There is a 10 inch copper pipe leading from each side connected to two 4-inch water towers placed on forward main deck; valves for operating the water towers are arranged in the pipes. There is also a 6-inch copper pipe running from discharge to top of pilot-house, with





Fire Boat for the City of Boston.

valve, and connected to the 3-inch water tower. The cast-iron pipe in deck-house has on each side six 3½-inch diameter dis-


Double Riveted
2'8" Inside diam.
Manhole at A
11" x 15"
Double Riveted
Cone braced with screw iron Braces, 3" rivets
6" C. To C. Braces 3" x 5/8"
6'3" Outside
1 Row screwed stays nut on each end
7'2" Outside diam. of shell
Inside of head 5'0"
Circumferential seam here double riveted
Longitudinal seams to have double butt straps, outer strap, double riveted inner strap, triple riveted butt straps, 3/8" thick
Centre line of boiler
Groove in top of head for stiffning
Top tube head
Centre of tube
Centre of tubes
Hand-hole at bottom
Back of Boiler
6½" Water space
542—2" Tubes 2½" Apart
Manhole A
Hand-hole at bottom
Hand-hole at bottom
Double Riveted
5¼" Water space
Let shell sheet run 12" past centre line at furnaces
4½" Water space
3'2½" Radius outside
4'9 5/32" Outside
4½" Water space
3'1" Radius inside
5'2" Outside
3'6" Inside
Stayed with screw stays well riveted over on each end
5¼" C. to C. 1" stays for 120 lbs. working pressure
14¾" x 17⅜" inside
Solid Bar
American Machinist
Hand hole at each leg at bottom

BOILER FOR FIRE BOAT.

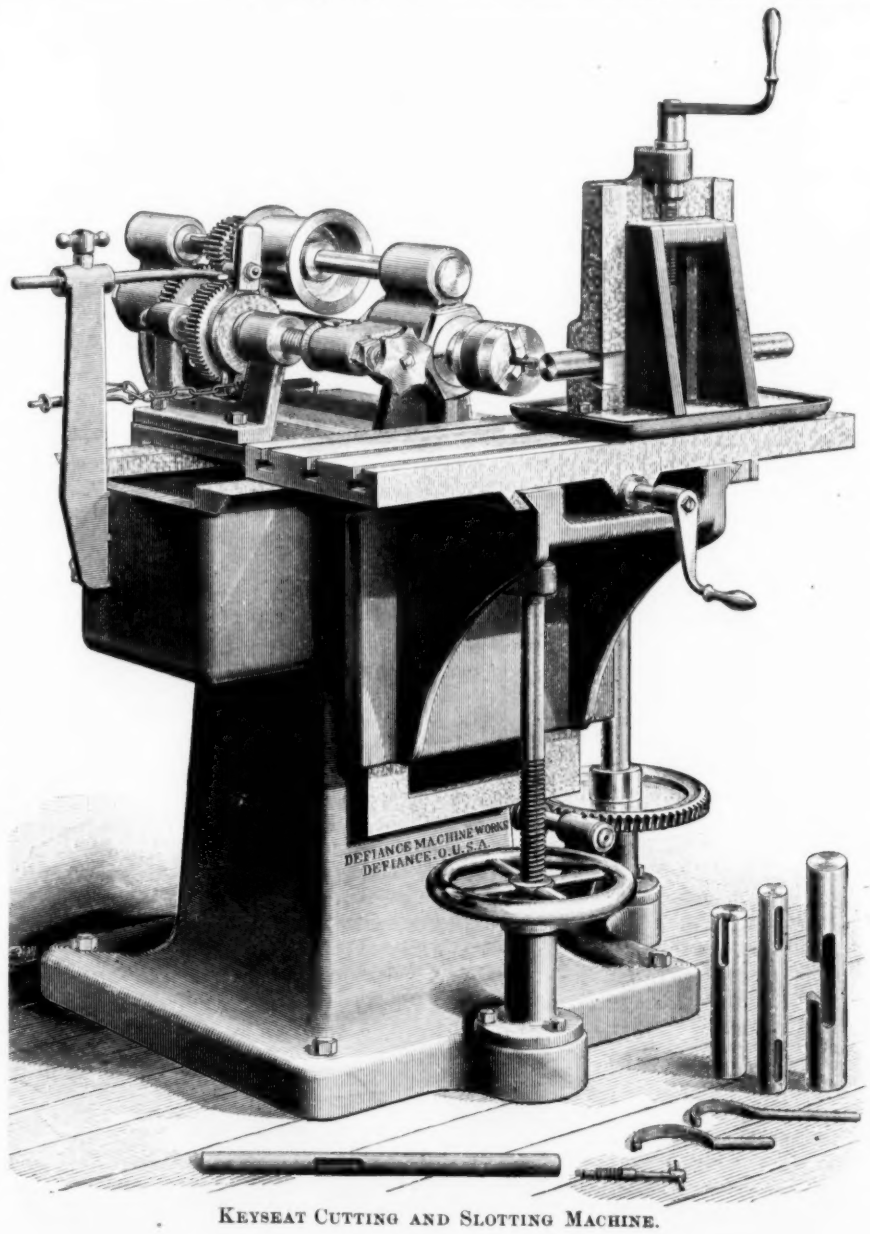
charge openings, fitted with composition pipes and discharge gates with hose-thread connections for attaching hose. The openings through house are well above the deck. Four of these openings on each side are fitted with 2½-inch reducers.

The towers are made of composition throughout, and each is operated by hand-wheels, giving a universal movement. The two forward towers are provided with 4-inch smooth nozzles, and the one on the pilot-house, with a 3-inch smooth nozzle.

The high-pressure cylinders of the pumps must stand a working pressure of 120 pounds per square inch; the low-pressure cylinders, 60 pounds; and the pump cylinders a working pressure of 220 pounds. In regular work the pumps will be run with a steam pressure of 95 pounds, and pump pressure 175 pounds; under these conditions, each pump must discharge at least 3,000 gallons per minute. It will thus be observed that this vessel is a fire fighting machine capable of delivering 25 tons of water per minute at an elevation of 250 feet. Pump cylinders and discharge piping will be tested by hydrostatic pressure to 330 pounds per square inch, and all pipes and joints must be tight under this pressure.

The hull is of wood. Length 110 feet over all; breadth of beam 26 feet over plank; depth of hold from top of ceiling to top of deck beam, on frame 3, 10 feet; draft 8 feet 6 inches. The following are the dimensions of some of the principal details of hull: Keel, white oak sided 11 inches, molded 11 inches; stem, white oak sided 9½ inches, molded 13 inches, outside of rabbet, bearded on forward edge to 3¼ inches; deadwood forward, white oak sided 10 inches, molded to conform to depth of floor forward and curve of stem and keel; deadwood aft, white oak sided 10 inches, molded to fill space between stern knee and shaft log; stern knee, white oak sided 10 inches, molded in throat 18 inches, and at nib 6 inches; frames, white oak sided 6 inches, molded at gunwale 5½ inches, at bilge 7¼ inches, at keel 8½ inches; planking, white oak 3 inches thick from keel to gunwale, and 11½ inches wide at gunwale; keelson, hard pine 10x15 inches; assistant keelsons, hard pine sided 9 inches; foundations for boilers, engine, pumps, and thrust bearings, hard pine; filling between frames for protection against ice extends from 30 inches below load water line to 15 inches above the same line, hackmatack, sided 6 inches; beams, hard pine, five of these are sided 12 inches, molded 10 inches in middle, and 7 inches at ends, five are sided 10 inches, molded 9 inches in the middle, and 6½ inches at ends; the remainder are sided and molded less according to their decrease in length; beams at side of boiler are of steel; deck plank, white pine 4x3¼ inches in the rough.

The hull and joiner work was built by John M. Brooks, of East Boston, and engines and boilers and all machinery, except fire pumps, by Brown & Miller, Vulcan Iron Works, Hudson and Morris streets, Jersey City, N. J.



KEYSEAT CUTTING AND SLOTTING MACHINE.

Keyseat Cutting and Slotting Machine.

We present herewith an engraving of a machine designed for cutting keyseats and splines in shafts, or for slotting holes through boring bars, tool-posts, etc.

The work is held, usually, in the vise shown, which is bolted to a platen 30 inches long, having planed T-slots, a 6-inch movement in line with the spindle and 10-inch vertical adjustment.

The cutters are made of drill rod, and are preferably held in a three-jawed chuck as shown, though if preferred the spindle is provided with a Morse standard taper hole.

The saddle, carrying the spindle, is automatically fed along the bed and reversed at each end of the cut, the cutter at the end of each movement being also automatically advanced the required amount for the next cut. This movement is effected by the feed screw and mechanism seen at the left of the cutter spindle. The cutter has a movement along the bed of 10 inches and will cut 2½ inches deep. Micrometer adjustments are provided for length and depth of cut, and when set and started the movements are entirely automatic.

The cutter spindle is of steel 1 1/16 inches diameter and runs in taper bronze bearings with means for taking up wear without disturbing alignment.

Pains have been taken to make the machine heavy enough to prevent vibration when doing the heaviest work; its total weight being 1,200 pounds.

It is made by The Defiance Machine Works, Defiance, Ohio.

Facts for Young Engineers—I.

BY W. H. WAKEMAN.

The pressure gauge on a steam boiler indicates the unbalanced pressure on that boiler, but cannot indicate the whole pressure of the steam. If the weight or pressure of the atmosphere is 15 pounds to the square inch, then 15 pounds of steam must be raised before the pointer on the gauge will begin to move. It is not convenient to demonstrate this, for the pressure of the atmosphere exists in a steam boiler under ordinary circumstances, before the fire is built, consequently if an outlet is opened after the fire has been burning for a time, the steam at a pressure less than 15 pounds, or whatever the atmospheric pressure is, will not rush out, because the air prevents it from doing so. If a partial vacuum is formed in the steam space, and we then build a fire and commence to get up steam, we shall soon have, say, 10 pounds pressure. If we now open the safety valve, the steam will not rush out, but on the contrary, the air will rush in, because the outside pressure is greater than that on the inside of the boiler. When we have steam enough to exactly balance the atmospheric pressure, if a valve is opened, no steam will come out, neither will any air rush in, and if we raise the pressure any higher the steam will escape in the usual way. Why, then, are not our gauges made so as to indicate the whole pressure of the steam? One reason is because it is a good plan to have a gauge indicate the pressure which tends to rupture the boiler, and this is just what our gauges show us. To illustrate, suppose that we have one boiler made whose diameter is 30 inches, and inclose it in another one whose diameter is 60 inches. We put 200 pounds pressure on the 30-inch boiler, and 100 pounds on the 60-inch. The real pressure that the small boiler has to withstand is 200 — 100 = 100 pounds. So it is with an ordinary boiler; for if there is an actual pressure of 80 pounds to the square inch within it,

and the atmospheric pressure is 15 pounds, then the boiler must be strong enough to withstand 80 — 15 = 65 pounds pressure, and this latter is what our steam gauges indicate, for the air envelops the boiler, and counteracts the internal pressure to an extent that is indicated by the barometer. When reading or studying books on the subject of steam engineering, the student should be careful to ascertain whether "gauge pressure" or "absolute pressure" is meant, for it makes a great difference, and the two should not be confounded.

When making calculatio.s concerning the pressure exerted on the pistons of steam engines, it is well to remember that the indicator pencil does not give us this total pressure, but only the effective pressure acting on the piston, represented by the area of the card or diagram. In other words, the indicator diagram never gives us the actual average pressure, but only the mean effective pressure. If the atmospheric line is drawn we can locate the zero line by computation, and may calculate the average pressure from it.

At the level of the sea, under ordinary atmospheric conditions, water boils at a temperature of 212 degrees Fahrenheit, and on account of this well known fact, some might think that it boils at this temperature under all conditions, but this is a mistake, for the boiling point varies with the pressure on the surface of the water. If it requires a temperature of 212 degrees Fahrenheit to make water boil, it is because there is a pressure of about 15 pounds to the square inch resting upon it, and if we take this water up to the top of a high mountain, where the air is less dense, and consequently exerts less pressure on the water, it will boil at a lower temperature. If we apply this principle in another direction, and put more pressure on it, as in the case of an ordinary steam boiler in use, it will require a much higher temperature to cause it to boil. If we know what the pressure of steam is, we can determine its temperature, and as the boiling water in a boiler has the same temperature as the steam, we can determine how many degrees of heat it requires to make it boil. The rule given us for this purpose is somewhat complicated, but as it may interest some readers, we give an illustration of its application. Suppose that we have steam at an absolute pressure of 40 pounds. To find its equivalent in inches of mercury, we multiply by 2.04, and our product is 81 inches. We must find the square root of the number so obtained, and in this case it is 9. Our next step is to find the cube root of this number, which is 2.08, and this we must multiply by 177.2, and subtract 100 from the product; $2.08 \times 177.2 - 100 = 258$ degrees, which is very nearly the correct temperature. Of course it is much easier and more convenient to refer to a table prepared for this purpose, and published in some standard work.

If cold water is pumped into a boiler it does not immediately acquire the temperature of the steam, but it soon reaches that point, and this being the case, why is it that all of the water in a boiler does not flash into steam? In order to explain this, it is necessary to refer to two kinds of heat, namely, sensible and latent. Sensible heat is that which is indicated by the thermometer, and on the Fahrenheit scale is calculated from 32 degrees below the freezing point as a standard, so that water boils at sea level at 180 degrees above the freezing point, or 212 degrees above zero, as before stated.

Latent heat is that which cannot be detected by the thermometer directly, but which must be put into water before it will boil or evaporate. Now the temperature of water or steam refers to its sensible heat, and therefore while the water in a boiler is of the same temperature as the steam, it does not pass into steam, because the latent heat necessary to evaporate it has not been added.

[As this article is intended especially for the enlightenment of the young engineer, and as we know that some of that class have some difficulty in understanding about latent heat, we would suggest that he can get some idea of how the latent heat is applied by actually putting a kettle of water upon the stove, if a gas stove so much the better, and noting the time that is required, first, to raise the temperature of the water to the boiling point, and, second, the time required to boil it all away, or to convert it all into steam. In the first operation the heat of the stove imparts sensible heat to the water, raising its temperature by the thermometer. In the second operation, which will be considerably longer than the first, the stove imparts only the latent heat to the steam, as the temperature of the water or of the liberated steam does not rise above the 212 degrees attained when the water began to boil.—ED.]

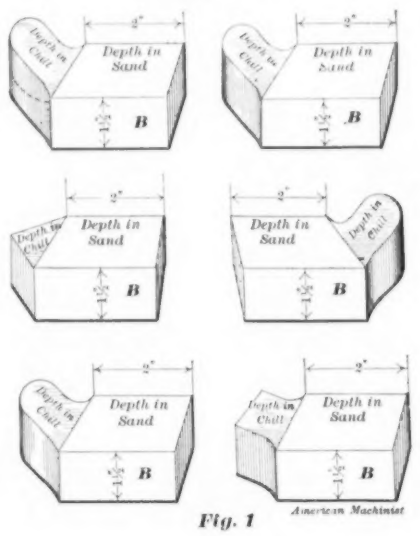


Fig. 1

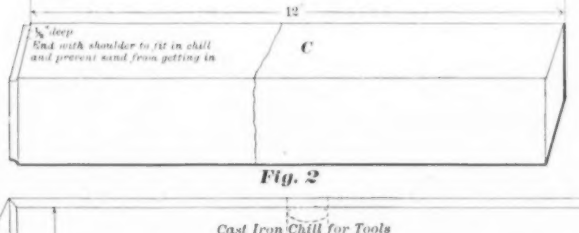


Fig. 2

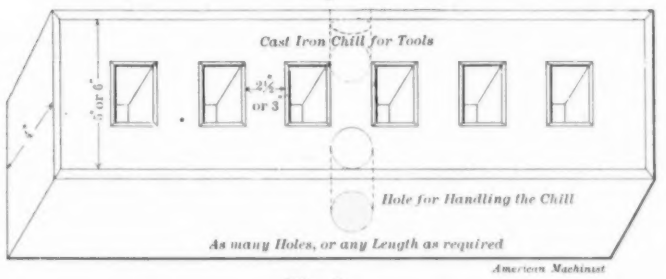

Cast Iron Chill for Tools
5 or 6"
2½" or 3"
Hole for Handling the Chill
As many Holes, or any Length as required
American Machinist

Fig. 3

MAKING CHILLED LATHE TOOLS.

LETTERS FROM PRACTICAL MEN.

Making Chilled Cast-Iron Lathe Tools.

Editor American Machinist:

Cast-iron lathe tools have not come into as general use as their efficiency and economy would seem to warrant.

For taking the first cut off pulleys, balance wheels, rope sheaves, drums—where grooved for wire ropes—eccentrics, rolls, etc., they are much cheaper than steel, and there are machinists who prefer them to any steel tool, even Mushet's. Their economy results from the fact that they are cheaply molded, require no redressing—with customary waiting of the machinist on the blacksmith; require grinding less frequently; when worn out into the cupola they go, and are converted into new tools or something else useful; and there is less capital locked up in lathe tools.

I have been told by several that they were not successful in making cast-iron tools. The process I have invariably obtained good results from is as follows: The machinist has made of wood, patterns, the exact shape he desires his cast iron tools on cutting edge to be, with two additional lengths same size of opening in tool post. From these patterns molds are made in sand. They are smoothed up and given a coat of lead (plumbago) blacking mixed with boiled linseed oil rubbed on smooth and thin.

These shapes are placed in a block of wood, with apertures in it to receive the shapes up to the shoulder, as shown on sketches, Fig. 1. This block is rammed up in a flask, and the block drawn out, leaving the shapes in the bottom of mold. In this flask and mold we cast the main chill (Fig. 3) from, or in which the chilled cast-iron tools are cast. The stock in this chill should be generous, as the heavier it is the harder, denser and tougher will be the resulting castings.

The chill obtained, then some patterns (one for each aperture in the chill) as per sketch, Fig. 2, are made. These should have an end with shoulder ¼-inch deep to enter the aperture to prevent the sand from getting into the aperture in chill. These should be the size of opening in tool post, or a little less (⅛ inch, say). The chill is placed in a box or nowel deep enough to give at least 12 inches length to the tool when rammed on end. The mold should be carefully made, that no cutting of sand occurs when poured. No cope is used; pour each one separately right on top; pour open. Here it may be well to say, pour as hot as possible, and fill as quick as possible. Have mold right near the cupola; catch right from the spout, the hotter the metal the deeper, harder and tougher the chill. I will add again, pour right into the open mold—throw it in if possible.

I have cast tools from all kinds of iron; the cold blast iron (chill wheel) mixtures make the best. The common soft foundry irons work very well, and good tools have resulted from the softest mixtures, but a good tool with dull iron, *never*, or slobbery pouring, *never*. The sharpening of these tools should be done by grinding, à la milling cutters, on the top surface only, as the chill is as per sketches, and if ground in front or sides the life of the tool is shortened thereby. I have seen some of these tools worn down, as per dots on 1—*B*.

The cutting edge needs to be backed up with as little clearance as possible.

With due observance of the above instructions, I feel sure no one need fail in making good cast iron tools. They will vary, some seem to be tougher and more lasting than others, same as steel, but if 25 per cent. are good, it pays well to make them.

Boston, Mass. L. C. JEWETT.

The English Lathe.

Editor American Machinist:

The general use of gap lathes in England, and the equally general non-use in this country, has been commented on as being something inexplicable. It seems not difficult of explanation. The "handiness" of an American lathe is so great that but few foremen would wait long for a small lathe to do a three-inch job, if a thirty-inch lathe were at leisure. If the iron in the upper works of such a 30-inch lathe were condensed to a swing of 20 inches, and some of it put where it would be very much in the way, the desirability of making the 20-inch lathe so it could do 30-inch work is obvious.

You comment favorably on the follow rest of the Richard's lathe. To me it is particularly bad. There are two wholly unnecessary joints, and both are arranged so that the strain to be resisted has the long end of the lever to act on.

The details of the bearing plates are not shown, but it seems to be intended that they remain fixed. If the plates be worn, by use on any one size of shaft, another shaft, a little smaller in diameter, cannot be turned satisfactorily unless the plates are first ground flat. Round plugs, passing through the post at 90 degrees angle to one another, are preferable.

The piece of work, shown in Fig. 6, is about one-quarter of the nominal swing of the lathe, and the tool post overhangs the bed to a considerable distance. With a 20-inch job the tool post would be supported by the extension of the carriage, which appears to be about 2 inches thick. As that thickness of iron will bend perceptibly by the weight of the tool post and its own weight, and as the tool must also be wholly overhung from all carriage support, rigidity does not appear to be a conspicuous feature.

SUPERANNUATED.

Cutting Square Threads.

Editor American Machinist:

In reply to "A. L. C.," of May 2d, I will say that I cut some screws that were 1⅛ inches by 9 inches, and 4 threads to the inch. I timed myself on them and found that I cut them in 15 minutes, taking 7 cuts with my spindle, running 32 revolutions per minute.

These screws were made out of tough iron, and were very near as hard to cut as steel. The only difference would be the number of cuts, as the speed would be slow enough for steel.

In grinding the tool I find it cuts best by grinding it even with the work. A good plan in cutting square threads is to make the body for the thread long enough so that you can cut off a half thread from the end after you have the thread cut. The first thread will not agree with the others, which is due to the tool having no cut on the one side and also to the lost motion of the machine.

C. F. ENGLEBERTE.

Chicago, Ill.

Inserted Tooth Mills.

Editor American Machinist:

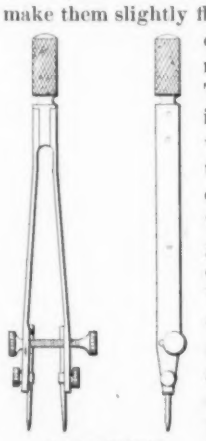
I was much interested in Mr. Randol's description of the Barnes' shops, and particularly in his account of the inserted tooth mills, in the issue of May 30th, but I fail to see how a slotting mill could be made with double teeth cut in the disks, and that would hold its size after grinding, although I can see how it could be done with two sets of disks, as Mr. Randol suggests.

WALTER GRIBBEN.

Small Dividers.

Editor American Machinist:

The sketch herewith shows a pair of small dividers that I have found very handy, and in which some of your readers may perhaps be interested. The legs are made of sheet steel in its soft state, riveted to the handle, and thinned down in the middle to make them slightly flexible, while the lower ends are left thicker to receive the screws. There are two adjusting screws, both of which are tapped into the same leg, so one of these screws tends to bring the legs together, while the other one pushes them apart. When both screws are tightened the dividers are practically solid, and will stand considerable careless handling without altering the setting. The points are ordinary carpet needles with the eye end broken off, and are held in place by the small studs and nuts at the extreme lower ends of the legs, which draw the needles into V-grooves on the inner faces of the legs. By this construction the points are easily sharpened on an oil stone by holding the needles in a lathe chuck, or are readily replaced when worn out, broken, or lost. The points may always be kept of the same length when desired, regardless of which one gets the



most use. When laying out a center on a cast boss, or when scribing a line parallel to the edge of a plate, you can temporarily make one of the legs "longer than it really ought to be." They have not any very great range of capacity, but in their own special field (scribing small circles accurately) they are ahead of anything I have seen yet. For the principle of rigidity, the idea of the push and pull screws on the same tool, I am indebted to my friend, Mr. C. H. Russom, but altered his design a little to accommodate the removable points.

WALTER GRIBBEN.

Spacing Holes—Flash Light Photography—Lighting Machines—Babbitting Solid Boxes.

Editor American Machinist:

I have read with considerable interest the notes upon spacing holes in machine work as set forth by various writers in previous issues of the AMERICAN MACHINIST, and have contributed one or two items, but there is one way for the rapid and accurate spacing of holes in straight work that I have not seen touched upon heretofore.

Fig. 1 shows a piece of iron in which it is desired to drill the holes *a*, *b*, *c*, *d*, etc., having known spaces between them, and all the spaces alike. Several of the methods described will enable the machinist to do this work with more or less accuracy, according to the method employed, and to the personal equation of the workman. One method described uses several distance pieces, one of which taken out each time a hole is drilled allows of very even spacing, but this method is not accurate, as it is almost impossible to make several distance pieces of exactly the same width or length

It is proposed to space the holes shown in Fig. 1 by the use of only one distance piece, as shown by Fig. 2. First, a piece of angle iron something like that shown by Fig. 3 is selected. The angle is planed up to 90 degrees, and a sharp, clean corner secured. Another piece of flat iron is riveted on top of the angle iron, as shown at *g* in Fig. 4. It is used as a guide for the drill, and, if necessary, the steel bushing can be inserted as shown, in order to prevent any appreciable wear by the drill. The piece to be drilled is shown at *e* in Fig. 4. It is placed in the angle iron as shown, and fastened securely by the clamp *a*. The distance piece *f* is then placed against *e*, and another square piece of iron, *e*, is brought against the distance piece, and also is securely clamped.

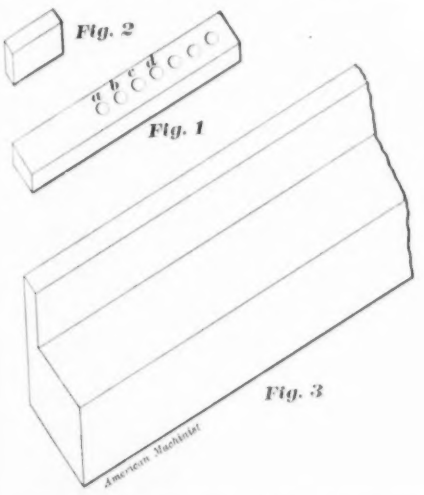


Fig. 2 Fig. 1 Fig. 3

This jig is now ready to drill a hole, and is placed under the drill press in the usual manner; after drilling at *g*, clamp *a* is loosened, distance block *f* removed, and the work *e* is moved up against *e*, and another hole drilled in the work. The accuracy of this method depends upon the nicety with which distance piece *f* is adjusted. In engraving (Fig. 4) pieces *e* and *e* are adjusted to such a distance that *f* can barely slide in between them. After one hole is drilled, piece *f* removed, and *e* and *e* brought in contact, another hole may be drilled in *e* in the manner first above described, after which it will be necessary to loosen up clamp *b*, slide *e* along to the right just enough to let *f* in between. After clamp *b* has been adjusted *f* can be removed, *a* loosened, and *e* moved forward again for another hole. These operations to be repeated until the required number of holes are drilled in *e*. It is easy to adjust *f* between *e* and *e* to the same degree of nicety each time by moving *f* up and down with the thumb and finger, and sliding *e* against it to the degree of tightness required; but when *e* and *e* are to be brought into contact, there is no way of telling when they are exactly in contact, or when they are left a very small fraction of an inch apart.

Fig. 5 shows a method of obviating this difficulty. The rectangular piece of metal *a* is put in place between *b* and *d* (Fig. 5) as shown; place a finger upon block *d* and move *a* back and forth until *d* is shoved up against it just tight enough. After *b* is removed and it is necessary to shove *d* against *e*, the

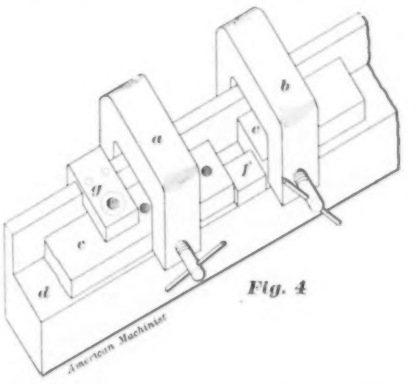


Fig. 4

distance piece *a* can be left in as shown in Fig. 6; there *e* and *d* are pressed together and *a* tested with the thumb and finger, the adjustment being made at *e* until *a* is held just as tight and no tighter than it was held in Fig. 5. Only one distance piece is required for spacing holes by this method, and it is apparent that all the spaces must be of the same length if measured off with the same distance block.

In the issue of March 7th Mr. F. H. Jackson described a method of improvising a

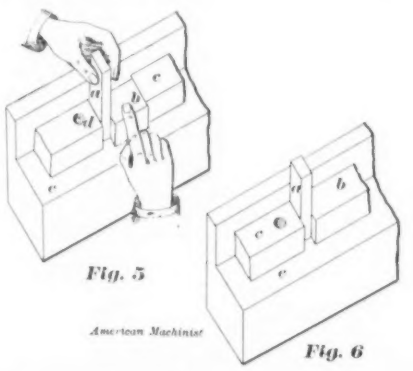


Fig. 5 Fig. 6

flash light from a clay tobacco pipe. I would not advise him to try the experiment unless he wishes to possibly injure his eyes or to run the risk of burning himself. Doubtless the tobacco pipe would make a fair flash lamp, but by all means attach a piece of rubber tubing to the stem to blow through. The face should not be exposed so close to the burning flash powder. Sometimes this substance explodes, particularly when the powder is not pure, or when it has been mixed with other ingredients to improve or accelerate its burning.

The hole through the stem of a tobacco pipe is not large enough to allow a proper quantity of air to pass; better build up an imitation of the tobacco pipe out of an inch nipple and a T of the same size; plug one end of the T, put a reducing nipple into the other end and attach either a small pipe or a rubber hose for the air to pass through. With 10 or 15 feet of tubing there would not be much danger of an explosion, even if it occurred while the mouth was applied to the tube, but a much stronger puff of air can be obtained by attaching a rubber bulb to the end of the tubing and pressing the former when it is desired to operate the flash light.

It is not always necessary to photograph machines at night, or even in dark places in the shop. Still, it is very handy frequently to be able to do so. It may not be generally known that with the present form of dry plate, photography can be carried on quite well by ordinary gas light, or, better yet, by the electric light. A simple piece of machinery can be nicely photographed by the light of a couple of good kerosene lamps. Just place the object in position upon a good solid foundation, adjust the camera, expose in the usual manner, except that where artificial light is employed other than flash light, the time of exposure must be lengthened frequently to many minutes, and sometimes to hours. Quite a good photograph may be taken in a comparatively dim light by setting up the camera and letting it remain focused upon an object for 12 or even 24 hours of daylight.

The correspondent who signs himself "Babbitt," Cold Water, Michigan, may pour a solid or any other form of box and have the lining remain tight without drifting or pening, if he will mix the metal lining in such proportions that it expands at the moment of solidifying. This can be done by the admixture of a certain portion of antimony. Type metal alloy is built up upon this principle. At the instant of solidifying, the metal expands (cast-iron does the same thing) and fills every crevice and corner of the mold. Some machinists claim that lead and antimony make a bearing too soft to wear well, but I can see very little difference between the wearing of a good antimony box and one lined with traditional "best babbitt." One proportion of antimony to three of lead makes an excellent hard metal lining. If four of lead to one of antimony are used, an alloy is produced which resembles very closely the common babbitt employed in heavy machinery. Still another proportion of lead, making five of that metal to one of antimony, gives an alloy which does not expand to so great an extent. It is softer and is used only by manufacturers of comparatively cheap machinery. Do not make the mistake of adding zinc to the lead under the impression that it is antimony. The two metals resemble each other very closely, but if zinc should be used it can be detected from the fact that it floats on top of the lead and remains there in spite of all attempts to mix the two.

JAMES F. HOBART.

Fast Lathe Work.

Editor American Machinist:

In reply to the inquiries of "English Tool Builder" I give the following facts regarding the job of lathe work referred to in my article published in your issue of April 25th, page 321:

The cone pulley is 4 inches, 6 inches, 8 inches, 10 inches diameter, 2¼-inch face. Lathe "Robbins" 16 inches swing; speed rather slower than the average for such diameter; cut for scaling, all the lathe will carry feeding by hand. Time to scale with $1.50 man, after he has been taught how, 8 minutes. Sometimes, if the cone runs out badly, 12 minutes; crowning, 10 minutes; hand tooling sides of steps, 5 minutes. Balance of 35 minutes will be used to file and trim all ready to polish. The chucking (boring) must be of the best; the iron fair in quality and cones well molded, fair and smooth, and all work to be fed by hand. There must be no power feed and the speed must not be too high. This job requires

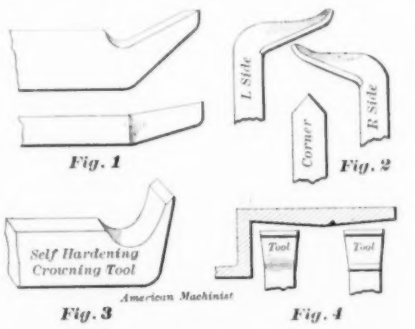


Fig. 1 Fig. 2 Fig. 3 Fig. 4

some practice, and the workman some bulldog tenacity.

If the English tool maker could have been in the F. E. Reed Machine Co.'s shop some years back he might have seen a foot-wheel of three steps, 1½ face by 23 inches, 21⅞ inches and 20¼ inches diameter, put in the lathe, turned, crowned, filed, bored, reamed and taken out in from 40 to 45 minutes, and the only place not finished was the back edge which rested against the face plate, and the job was well done. There are lots of my shopmates to witness this, and there are lots of *my boys* that have done the same; but let a pulley run out badly, and it will take, say, two hours for the job. Why? Had to use power feed. That accounts for it.

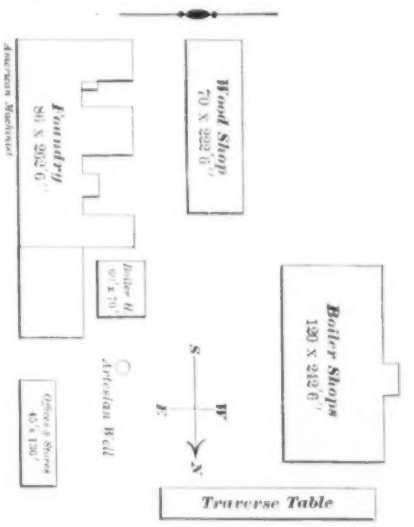
My article, "Fast Lathe Work," was written to show what can be done by anyone by the proper use of tools, and by really trying to use them with skill and judgment. I have been many years at this special work, and a job hand, which explains. I send some very rude sketches to explain the tools and their use.

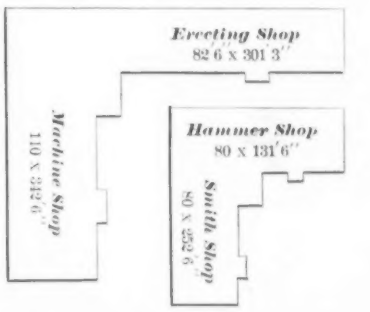
Fig. 1 is a side and a plan view of the scaling or roughing tool. It is made of self-hardening steel, and the face has a little side rake. Fig. 2 shows the tools for the inside surfaces at each end of the pulley, and the tool for the corners. It is very important that the crowning tool be set in the tool post so that it has the same clearance on each step.

Fig. 3 is the crowning tool, made of self-hardening steel, and Fig. 4 shows the manner of its application to the work.

ISAAC CHICK.

43 Irving St., Worcester, Mass.





Siemens-Halske Shops in Chicago.

The Siemens-Halske Company, Chicago, who rented the idle Grant Locomotive Works, immediately after the destructive fire August 1, 1894, in their Siemens-Halske Chicago establishment, will very soon come into sole ownership of the entire Grant establishment at "Grant Works" Station, on the prairie in Cicero, seven or eight miles west of the Court House, Chicago. These very fine and extensive shops are located on level prairie ground and comprise a number of very large buildings arranged in the general form of three sides of a quadrangle open to the south.

The magnitude and arrangement of these shops will be understood by reference to the sketch of ground plan given herewith.

To the very large machine tool plant of the old Grant Locomotive shops, much of which was of the latest and best, the Siemens & Halske Company have already added a great number of fine tools, and now that they have come into virtual ownership, will proceed immediately to make such removals and additions in the line of metal working machinery, as will enable them to carry on their vast operations in the most economical manner possible, so far as having the latest and best machine shop outfit procurable is concerned.

The Siemens-Halske Company is now very busy on large slow-running dynamos of their widely known type for various electric railway systems.

AMERICAN MACHINIST

PUBLISHED EVERY THURSDAY

BY THE

AMERICAN MACHINIST PUBLISHING CO.,

203 BROADWAY, NEW YORK.

Fred J. Miller, Pres't.
Charles W. Biglow, Treas.
C. A. Hansmann, Sec'y.

Fred J. Miller, Editor.

Special Announcements.

☞ *We publish nothing in our reading columns for pay, or in consideration of advertising patronage. Space in the advertising pages only is for sale.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

☞ *All communications for, or relating to the reading columns should be addressed to the editor. All other communications to the company, as above.*

The ***American Machinist*** *is not interested in any particular patents, products or factories, to the prejudice of others, but is devoted to the interests of all those who have to do with designing, building, selling and using machinery.*

☞ *Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$3.00 a year in advance, postage prepaid, in the United States, Canada, and Mexico.
$4.00 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,

New York, is the Publisher's Agent, and dealers are supplied by all its branches throughout the United States and Canada.

FOR EUROPE:

The International News Company,

Bream's Bldg's, Chancery Lane, London, E. C., Eng., or Stefanstrasse 18, Leipzig, Germany, will receive subscriptions for the American Machinist, at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.

Subscriptions received in Paris, France, by E. Terquem, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. Williams, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, JUNE 20, 1895.

CONTENTS.

PAGE.

Cutting Bevel Gears in a Universal Milling Machine. By Jarno 481
The Taylor Hydraulic Air-Compressing System. 482
Some Thoughts on Machine Design—II. By Prof. De Volson Wood 483
Fire Boat for the City of Boston 484
Keyseat Cutting and Slotting Machine 485
Facts for Young Engineers—I. By W. H. Wakeman 485
Letters from Practical Men: Making Chilled Cast-iron Lathe Tools. By L. C. Jewett.... The English Lathe. By Superannuated.... Cutting Square Threads. By C. F. Engleberte .... Inserted Tooth Mills. By Walter Gribben ... Small Dividers. By Walter Gribben ... Spacing Holes—Flash Light Photography—Lighting Machines—Babbitting Solid Boxes. By James F. Hobart.... Fast Lathe Work. By Isaac Chick. 486, 487
Siemens-Halske Shops in Chicago 487
The Best Machine Shop 488
Co-operation of the Manufacturer and the User of Machinists' Supplies 488
Electricity on the Elevated Roads in New York 488
Literary Notes 489, 490
Questions and Answers 489
A Modern Machine Shop—II. By Horace L. Arnold 489
A New Nut-Locking Device 491
Robertson's Waste Oil Filter 491
The Engineers in Detroit. By Chas. A. Strelinger & Co. 491
New Catalogs 492
Manufactures 492
Machinists' Supplies and Iron 492

The Best Machine Shop.

A machine shop, or any other industrial structure, is as much an invention as any machine to be sheltered and used within its walls. Like any other invention, the design of the shop itself may be very good or very bad; in most cases, unhappily, use proves it to be far from wholly satisfactory in every particular, but a shop once built is very likely to be used for a long time without material alteration for the better. It would therefore seem of the first importance that the mechanical world should have all possible information on the subject of shop structures, especially at this time when so very many old and prosperous concerns see in the present revival of business a warrant for changing from the dark and crowded quarters where they have achieved success, to more roomy locations where they may build work with less labor and more comfort.

The essential points of a good machine shop would seem to be, first of all, after weather-proof qualities, abundant light, room enough so that one workman is not in the way of another, short lines of travel, easy handling of material, and suitable offices.

These are very simple features indeed, but it does not in the least follow that they are easily attained. Very few machine shops are well lighted, and a very great many indeed are miserably dark; very few are so arranged that there is no needless handling of work in progress; only a few are so arranged and equipped that the handling of work is effected with the least possible labor cost and time loss. Very few machine shops have perfectly satisfactory offices, and few indeed have good or comfortable drafting rooms. Here and there throughout the country are shops which have one or two especially well planned and well constructed features, but are very faulty in other points, and nothing perhaps can serve a more useful purpose than to give our readers who are owners, constructors and workers in machine shops and other industrial establishments, opportunities for studying some of the latest ideas and constructions.

Anyone interested in shops can get almost as good an idea of the Gates shops from this and a following issue as could be gained by visiting them; which last is not always convenient or even possible. We propose to publish descriptions of other shops as opportunity offers, and our readers can depend upon it that these articles will not be in the line of the too common "write up," but will be published entirely at our own expense, and for no other reason than because we consider that our readers will be benefited by or interested in them.

As these accounts will be read by a very great number of persons who will immediately or ultimately have to do with the planning and erection of buildings where large numbers of human beings will pass the greater part of their waking hours, it would seem not out of place to give at the outset a little space to the consideration of physical comfort of working men of all conditions, from the head of the establishment—very often the hardest worked man inside the walls—down to the humblest floor sweeper or stock handler in the shop.

The most economical point of cut-off for the comfort of the industrial animal has never been certainly determined.

It is certain that the cheapest and rudest buildings—dark, dirty, unventilated, unheated and unhealthy—do not secure the highest economy, but it is not so easy to define the limit in the other direction, because few if any examples can be found in which the limit has been passed or certainly reached. That it pays to give more attention to physical comfort than is generally given to it in the construction and equipment of shops is morally certain, as the testimony of owners of the best shops abundantly proves.

It would seem that comfort may be a prime consideration of profitable machine shop operation to a point considerably beyond present American practice, which is believed to already exceed European practice in this particular. It is true that workmen are almost as silent on the subject of physical discomfort as the dumb animals, and that good work and great production at low cost can be secured without much consideration of fatigue, accommodations for meals eaten within the works, or cleanliness of workmen, who almost never complain in words. Yet it would really seem that in planning shops it might prove truly economical to provide as fully as possible for personal comfort up to the point where cleanliness and decency can be attained by the self-respecting workman, and where well-known hygienic laws can be observed.

Men do the best work, mental and physical, when they are in the best physical condition, and when the least possible proportion of their vital forces is sapped in merely maintaining existence; in other words, where the environment is most conducive to physical well being. "Shopitechture" is a more complicated science than many would suppose, and does not end with the design of four walls strong enough to support a roof and the line shaft, and a floor strong enough to hold the machinery.

Co-operation of the Manufacturer and the User of Machinists' Supplies.

There is a touch of unfairness in comparing the output of the modern shop with that of one that flourished in the good old times. While the average machine shop of to-day will turn out vastly more work than a shop of the same size, or, say, which employed the same number of men, in the not very long ago, much of this apparent superiority is in the fact that so much of the work is done somewhere else. The product of the old shop represented the work of the men in the shop and no more. There is no shop to-day that does not in its product represent the work of other skilled and unskilled workers scattered in various shops or factories throughout the land. Men are still working in our shops who do not have to strain their memories to remember when every nut used in the shop was welded up from the bar, tapped, faced, and filed up in the shop.

It would probably be quite difficult to form any estimate of the numbers of workers outside the shop itself who should now be counted as among its producers. If such an estimate should be attempted, the result would probably never show as many working upon the shop's product outside the shop as in it; for no establishment, we imagine, will find its average bills for tools and "supplies" amounting to anything like as much as its bills for labor and raw material. When we see the vast increase in the output of the average shop under the modern supply system, without anything like a corresponding increase in the total hands employed, wherever they may be, we realize the importance of producing all those supplies in the greatest perfection. By the general term of "supplies," as here used, we mean to include all the small component parts of machinery that are now usually factory-made, such as bolts, nuts, studs, washers, set screws, pipe fittings, etc.; all small tools, such as files, taps, reamers, drills, milling cutters, emery wheels, etc., and also the machine tools themselves. Now it happens that of all the makers of these things only the machine tool builder is to any extent the user of his own product, or is in any position to know with any certainty whether it is satisfactory, whether it can be improved, and wherein, whether it is defective, in what the defects consist, and how they may best be remedied. The makers of emery wheels, for instance, are often in as bad and pitiable a position as the doctor often is who knows nothing of his patient's habits, or what has caused the trouble that he is called in to set right, or whether even his questions will be answered with any truthfulness; who does not know whether his instructions will be followed, or whether the medicines prescribed will go into the patient's stomach or out of the window. The treatment that the emery wheel has received, and the amount and excellence of the work accomplished by it, notwithstanding, would seem to prove it a marvelous agent, and still capable of widely extended usefulness. Our contributor, Mr. C. H. Norton (June 6th), shows up quite fully the outrageous treatment the emery wheel has received, and his whole article is a strong argument for the interchange of information and experience between the makers and the users of emery wheels, and the acceptance by each of those suggestions which the other is in the best position to offer. The necessity of comparing ideas between the maker and the user, and of co-operating toward the attainment of the best results is probably nowhere more imperative than in the case of the emery wheel, but there are a plenty of other instances of sufficient importance, and no article made has all the knowledge and experience as to its manufacture and use concentrated at any one point. Of course in this matter it should not be necessary to say a word of the necessity of honesty and truthfulness, for these in this connection are only common sense, but even common sense is sometimes in need of a good word.

Every machinist knows all about files, and the art of file making is old enough, but it is still possible to compare notes to mutual advantage even upon this topic. We remember how once upon a time a firm was using a great number of large mill files for filing some large drums in the lathe, and the files were not giving satisfaction. They wore out very rapidly, and the file agent could not tell what the trouble was, while the file buyer continually kept beating the price of the files down. It was finally determined and come to be known by the file maker, as well as by everybody else, that when the drum was revolved too fast, the high speed was the cause of the rapid destruction of the file, and that the files when used with proper speed were very good. In this case honesty might not have arrived at the solution as quickly as knowledge on the part of the seller might have accomplished it. As a matter of self-defense, or rather, in the line of his business, for both offensive and defensive purposes, the seller should know as much as possible as to the use of the article that he sells, and should be capable of knowing a little more all the while. An experienced machinist should be a good man to sell supplies, and, if all right, should be welcomed in the shop as a missionary. Some heathen think that the missionary's mission is to be gobbled up, but he has better uses sometimes.

Electricity on the Elevated Roads in New York.

The definite announcement that the Westinghouse Company, of Pittsburg, has secured the contract for the equipment of the elevated roads in New York with electric motors, to take the place of the present steam locomotives, the contract amounting to between six and eight millions of dollars, does not come as a surprise to those who have watched the tread of events, and it was foreshadowed by our editorial correspondence from Chicago during the Columbian Exhibition, in which attention was called to the peculiar adaptability of electricity to service on elevated railways. Our opinion expressed at that time was based upon a study of the Intramural road at Chicago, which we believe did more than any other one influence to advance electric traction.

We may look now for a renewed crop of declarations to the effect that "the locomotive is doomed, and that a few years will see it relegated to the limbo of forgotten monstrosities which served well in its day, etc.," but all this will be premature and unwarranted. Electric traction is in our opinion a long way from even competition with the locomotive in pulling heavy and fast trains long distances on surface roads. On elevated urban roads it has very great advantages over any other known method of applying power, but some of the most important of these advantages disappear on other roads.

Literary Notes.

POPULAR ENGINEERING; being interesting and instructive examples in Civil, Mechanical, Electrical, Chemical, Mining, Military and Naval Engineering, graphically and plainly described, and specially written for those about to enter the engineering profession, and the scientific amateur; with chapters on perpetual motion, and Engineering Schools and Colleges. By F. Dye.

The subjects embraced in this book are well enumerated on the title page, as given above. It is written for the young, or non-professional men, and the aim of the author is to set forth the kind of work a youth who aspires to become connected with some department of the engineering profession, will have to deal with. For this purpose, some of the most important engineering achievements in each department are illustrated and very briefly described. Most of the matter is simply descriptive. The author does not show how different parts of structures should be constructed, nor does he give any methods or rules for finding the proportions of parts, but simply confines himself to descriptions, incidents, and facts interesting and instructive.

The chapter treating on perpetual motion contains nothing but a series of failures, though not lacking in ingenuity and interest, as might have been expected. They are chiefly extracted from patent records, by which it seems that their inventors had considerable faith in their creations, and it is equally evident that the machines were not made and tested before the expense of such protection was incurred. In connection with subject the author says: "Amongst the originators of some eighty-four patents, of which the subject is self-motive power, there figure a prince, two counts, a baronet, doctors, merchants, a brewer, and tradesmen of all kinds. It is somewhat pleasing to see that those bearing the title of engineer are limited to two people only." We recommend a perusal of this chapter to our perpetual motion friends and cranks.

Many of the cuts have been taken from engineering journals, and some from catalogs. Some of the cuts are very poor ones, and tend to lessen the value of the book. It contains 469 pages, including an index. The size of page is 7x9½ inches.

It is published by Spon & Chamberlain, 12 Cortlandt street, New York. Price, $3.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(251) G. F. L., Akron, O., writes: I want to build a water motor but do not know enough about their construction and size to produce a given horse-power, and to proceed with the work intelligently. Kindly refer me to some book giving details of construction, amount of water required, etc. *A.*—"Practical Treatise on the Construction of Horizontal and Vertical Water Wheels," by Wm. Cullen, may suit your purpose.

(252) H. B., Brussels, Belgium, writes: We use to a great extent oiled paper or tracing paper from which we make our blue prints for the works. These tracings after a year's use become broken and wear out with rapidity. Are you not acquainted with a tracing paper of better quality or more suitable for drawing upon with ink, and through which the light passes well for blue printing? *A.*—In our experience, we found that all tracing paper that we could get hold of will rot in time and become useless. We therefore abandoned its use and adopted tracing cloth in its place. From this as good blue prints, if not better, can be made.

(253) W. L., Vancouver, B. C., writes: I am about to build a triple expansion engine for a launch and have computed the following dimensions for cylinders: High-pressure cylinder, 3¾ inches diameter; intermediate, 6½ inches diameter; and low-pressure cylinder 11 inches diameter; all 6 inches stroke; boiler pressure 200 pounds. I am anxious to know if these dimensions are correct. *A.*—The diameters of cylinders are correct, the stroke is usually about .66 times the diameter of the low-pressure cylinder; this proportion will give a stroke of 7¼, say 7 inches. A steam pressure of 200 pounds per square inch for a triple expansion engine is rather high for economical running; a steam pressure of about 170 pounds per square inch will give more satisfactory results. 2. Steam is to be cut off at $\frac{6}{10}$ of the stroke, and the engine is to run at a rate of 450 revolutions per minute; I find that the engine will develop about 30 horse-power. Is this about right? *A.*—Yes. 3. The length of the launch is 30 feet, beam 6 feet, what will be the probable speed? *A.*—That depends on the lines of the boat. On general principles, we should say about 11 miles per hour.

(254) J. L., Dayton, Ohio, writes: Please give the size of opening or port for a steam cylinder 6 inches diameter, piston speed 600 feet per minute. Please give formula. *A.*—The area in square inches of a steam port is obtained by multiplying the square of the diameter of the cylinder in inches by the piston speed in feet per minute, and dividing this product by 7,639. In symbols we have:

$$\frac{D^2 \times S}{7{,}639} = A;$$

in which D = diameter of the cylinder in inches, S = piston speed in feet per minute, and A = area of steam port in square inches. Applying this rule to your case we have,

$$\frac{6^2 \times 600}{7{,}639} = 2.82 \text{ square inches}$$

for the steam port area. The length of the port should be made as long as the design of the engine will admit, so as to obtain a comparatively rapid opening of port and with a short travel of valve. Frequently the length of port is equal to ⅔ of the diameter of the cylinder; adopting this proportion, the port will be 4½ inches long. The width of port is obtained by dividing the area by the length of port; this gives us 2.82 ÷ 4.5 = .626, say, ⅝ inch for the width of port. 2. Please give formula for computing the dimensions of spiral gears. *A.*—Your question is so indefinite that to answer it we would have to write a treatise on the subject. We therefore must refer you to the "Practical Treatise on Gearing," published by Brown & Sharpe Mfg. Co., Providence, R. I.

(255) R. F. C., Providence, R. I., writes: Please explain why steam can be used with greater economy at high piston speeds than it can with low piston speeds. *A.*—Because smaller cylinders are used for the required power, giving smaller radiating surfaces for losing the heat, and also because each cylinderful of steam has a less time in which to lose heat. The introduction of high speeds was brought about by the competitions of engine builders who found that they could build and sell high-speed engines more cheaply than slow-speed engines, so that the high-speed engine, within reasonable limits, shows economy in first cost as well as in the application of the steam. 2. Would a triple-expansion engine, in which the piston speed of the high and the intermediate pressure cylinders was low, and the piston speed of the low-pressure cylinder was high, be as economical in the use of steam as an engine of the same type that had a uniformly high piston speed in all the cylinders? *A.*—It would not. If we were compelled to choose a different speed for any of the cylinders we would have the low pressure the slowest. 3. Will an engine which has small cylinders and which makes a large number of revolutions per minute, be as economical as an engine that has larger cylinders and which makes fewer revolutions per minute, the horse-power and piston speed of both engines being equal? *A.*—The piston speed and the horse-power being equal, the cylinder diameters would be equal, and the only difference would be in the length of stroke. A shorter stroke and increased number of revolutions means an increased loss in clearances, and usually an increase in the proportional friction of the engine against the decrease in radiation by the shortening of the cylinder, so that only within narrow limits of change could any economy be shown.

(256) Engineer, Philadelphia, Pa., asks: What qualifications are required for obtaining a marine engineer's certificate? *A.*—Before an original license is issued to a person to act as an engineer, he must personally appear before some local board or a supervising inspector for examination. No original license will be granted to anyone to act as engineer, except for special license on small pleasure steamers, who cannot read and write, or who has not served at least three years in the engineer's department of a steam vessel, or as a regular machinist in a machine shop, provided that any person who has served for a period of three years as a locomotive or a stationary engineer may be licensed to act as an engineer on steam vessels after having had not less than one year's experience in the engineer's department of a steam vessel. The examination, of course, will be such as to test the ability of the applicant for the position applied for. 2. How many grades are there? *A.*—Chief engineers of ocean steamers, chief engineers of lake, bay and sound steamers, chief engineers of river steamers, first, second and third assistant engineers, and special engineers. 3. Are there any publications which will give me all information on this point? *A.*—We do not know of any excepting the general rules and regulations prescribed by the Board of Supervising Inspectors of Steam Vessels. You may be able to get a copy of these by writing to the Secretary of the Treasury, Washington, D. C. 4. What is the most common kind of refrigerating plant in the United States? *A.*—The ammonia compression types of refrigerating machines are mostly used. 5. Can I get a book of instructions as to the management and working of these machines? *A.*—"Theoretical and Practical Ammonia Refrigeration," by I. I. Redwood, may be of aid to you; it is published by Spon & Chamberlain, 12 Cortlandt street, New York. Price, $1.

(257) S. L. H. & Co., Boston, Mass., write: We desire to use steam in a shop about 200 feet from the boiler, and we want it at a higher temperature than we can obtain after carrying it so long a distance through pipes. The pipes are well protected, and yet the temperature is too low. Can you advise us of any safe method of superheating this steam by an appliance of gas to the pipes through which it passes? *A.*—This inquiry seems to have been written under a wrong impression, and after all it leaves us more or less in the dark in attempting to answer it. The protection of the pipes, however effective it might be, would not affect the temperature of the steam delivered so long as the pressure was maintained. If the pressure is not maintained, or nearly so, the pipes may not be large enough for the volume of steam required to be transmitted. Increasing the pressure at the boiler and maintaining that pressure at delivery would increase the temperature of delivery. It is, of course, possible to pass the steam pipe through a chamber heated by the combustion of gas, but we doubt if it can be done with safety and satisfaction. Saturated steam may be depended upon to exhibit a temperature corresponding with its pressure, but when the steam is superheated there is no check or guarantee as to the temperature attained. With steam flowing at a uniform rate it might be possible to so regulate a gas heater as to deliver the steam at a certain required temperature, but if the flow of steam were diminished the same adjustment of the gas heater would heat the steam hotter, and if the flow of steam were stopped entirely the gas might burn the pipes or overheat them to a dangerous degree. If the actual fact in this case is not that the temperature of the delivered steam is too low, but that it has not a sufficient heating effect or does not transmit enough heat units, that can be remedied by simply increasing the volume of steam delivered.

(258) W. F. H., Leavenworth, Kan., writes: Please recommend a book which treats on the size and design of chimneys for steam boilers. I have a chimney to build for three tubular boilers rated at 60 horse-power each. The chimney is to be built in the Mississippi Valley. Any information which you can give in regard to this will be most thankfully received. *A.*—"Practical Treatise on Heat," by Thos. Box, treats, among other things, on the size of chimneys, it is a good book to have. You will also find rules for determining the size of chimneys, and much other useful information in regard to them in the "Mechanical Engineers' Pocket-Book," by William Kent, which has just been published by John Wiley & Sons, 53 East Tenth street, New York; it gives the most recent practice. There are many rules published, giving varying results, but we believe the rules published in the pocket-book above referred to are reliable. In proportioning chimneys the hight is generally first assumed, with due consideration to the hights of surrounding buildings or hills near the proposed chimney, the length of horizontal flues, the character of the coal to be used, etc., and then the diameter required for the assumed hight and horse-power can be found by the following formula which is probably used by engineers to a greater extent than any other one,

$$E = \frac{0.3 \times H}{\sqrt{h}},$$

in which E = effective area in square feet, H = horse-power, and h = hight of chimney in feet. The above formula reads: The effective area of the chimney in square feet is equal to $\frac{3}{10}$ of the horse-power divided by the square root of the hight of the chimney in feet. This formula is based on a coal consumption of 5 pounds of coal per horse-power per hour. To show the application of this formula in your case, let us assume that the hight of the chimney is to be 80 feet, the horse-power being given at 180, we then have,

$$E = \frac{0.3 \times 180}{\sqrt{80}} = 6 \text{ square feet}$$

for the effective area of the chimney. The actual area, in practice, should be greater, because of retardation of velocity against the walls. On the basis that this is equal to a layer of air 2 inches thick over the whole interior surface, we have the following formula for finding the diameter of a round flue:

$$D = 13.54 \times \sqrt{E} + 4 \text{ inches},$$

in which D = diameter of the flue in inches, and E the effective area in square feet as before. From this we get,

$$D = 13.54\sqrt{6} + 4'' = 36 \text{ inches}$$

for the diameter of the flue. If the chimney is to be square, then for finding the side of the flue use the following formula:

$$S = 12 \times \sqrt{E} + 4 \text{ inches},$$

in which S is the length of the side. From this we get

$$S = 12 \times \sqrt{6} + 4' = 33\tfrac{1}{4} \text{ inches}$$

for the length of side. The effect of horizontal flues leading considerable distance to the chimney is to lessen the draught. Such flues ought to be of an area at least one-quarter greater than that of the chimney. When horizontal flues are 200 feet in length, the area of the chimney should be increased by 15 per cent. The chimney should be as nearly central to the boiler plant as possible so that each boiler will have as nearly an equal distance as possible from the chimney. If you have had no experience in building chimneys we should advise you to let a competent steam engineer determine the size.

Business Specials.

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 472.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

To established manufacturers—A new engineering specialty on royalty. Box 22, AM. MACHINIST.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular. Norman W. Henley & Co., 132 Nassau street, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 208 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

A Modern Machine Shop.—I.

BY HORACE L. ARNOLD.

The readers of the AMERICAN MACHINIST are of course interested in machine shops, and especially in knowing what constitute good and bad features in machine shop design. No better way of becoming posted upon this important subject can be devised than by the study of modern examples of shop construction—examples in which experienced manufacturers and mechanics have attempted to secure the best possible conditions for economical production of ma-

chinery, with men working under comfortable conditions.

Such an example is found in the shops of the Gates Iron Works, at 560 Elston avenue, Chicago.

The new Gates shops stand on the east side of the street, and south side of the railway, and the foundry is south of the machine shop. It is thus made possible to put the drawing room on the north side of the building. The main offices, of course, front the street. Covering the machine floor with a traveling crane necessitates a high shop building for the main part, and brings the gallery into existence if the outer walls are carried straight up. This gallery is very often used for the light machine tools, which arrangement involves long lines of back and forth travel for work in process of finishing and erection. In the Gates shops the gallery has been used as follows: The entrance for officers and workmen is at the large door to the right in the Elston avenue front; inside this door is the office stairway to the right against the wall, and to the left is a locked door opening on to the main machine floor, reached by four or five steps of stairway, as the main floor is two or three feet below the sidewalk level. The office stairway is easy, with a right-angle turn and landing in the middle so that the visitor reaches the gallery corridor facing the north, with a glass partition giving a full view of the shop interior on

Fig. 1.

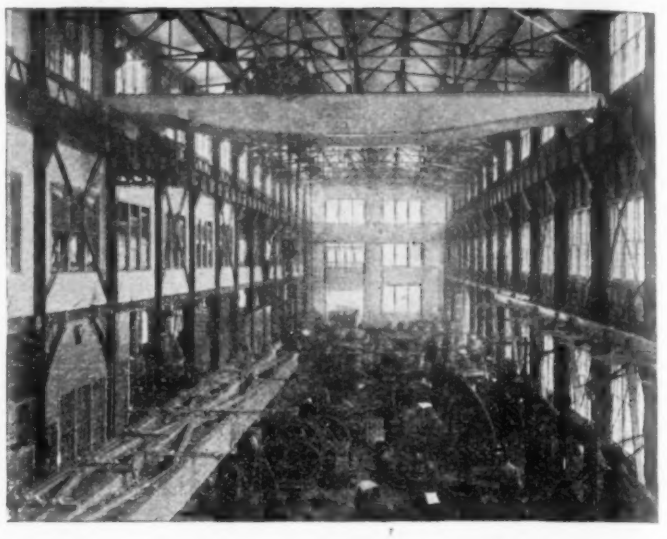


Fig. 2.

THE GATES SHOPS.

his right hand, and the office of Mr. P. W. Gates, president and superintendent, on his left. The interior view, Fig. 2, is taken from the second window of this north and south corridor, and the corridor interior looking north, Fig. 3, is taken from the head of the entrance stairway. The offices are finished in oak; every officer and every man in control of a division of work has a separate room, with his stenographer and typewriter where needed. In speaking of this arrangement, Mr. A. J. Gates, vice-president, said: "We had suffered great inconvenience in our old down-town shops from want of privacy in our offices; I can do twice the work with half the labor when I am in a room by myself, and, so I believe, can any other man; all of these men in separate offices are also in direct personal communication at times with our customers, and it is, of course, of great importance that such conferences should be uninterrupted; there may be no great privacy in the matters discussed, or, again, there may be very good reasons for desiring conversation to be heard by no one except those taking part in it; I know that we do business here in far less time than ever before, and with no annoyance at all. We are satisfied, perfectly, with our office arrangements."

This west corridor is quite wide, and is furnished with a table, chairs, water cooler, and telephone for general use. At its north end is a telephone in a closed room. The north corridor, also separated from the main shop floor by a clear glass partition, is shown in Fig. 4, and ends at its extreme eastern extent in closets on the right, and the drafting room door on the left. The pattern shop is reached from a door in the extreme eastern end of the drafting room, and at the eastern end of the pattern room there is a stairway down to the main machine shop floor, landing near the extreme eastern end of the shop, on the way to the foundry. The main floor is 328 feet long by 50 feet wide, covered by a 20-ton electric traveling crane.

The floor does not support any permanent structure. The flooring is nailed to sills laid in clay which reaches the under side of the floor boards. The heavy tools are set on concrete foundations about 5 feet deep, reaching down to the original clay. Such tools as rest on the floor are carried on round cedar paving blocks, 5 inches or 6 inches long, set close together on the boards, and planked over the top. The floor is wholly a temporary matter, and can be renewed at any time in any part without general disturbance of shop operations; and at the same time, as the flooring rests directly on the clay, it is capable of carrying any load without deflection. This load-bearing capacity is an important feature of the Gates

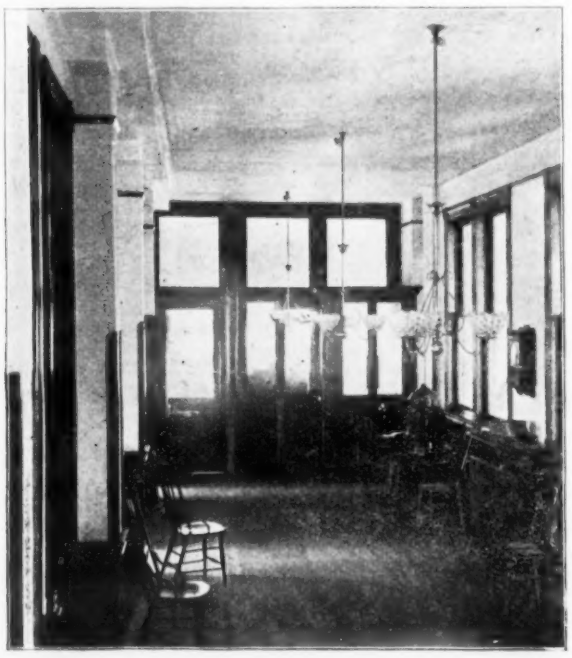


Fig. 3.

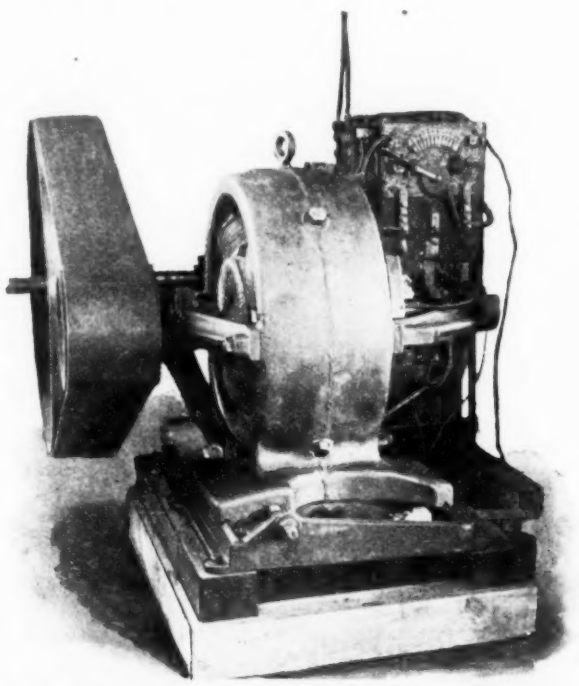


Fig. 6.

THE GATES SHOPS.

flooring, as their line of stone crushers, parts of which are shown in the foreground in Fig. 5, are very heavy. The fact that these new shops have been occupied only for a very short time, and that much of the material has not yet been moved from the place where it was originally unloaded, gives the main floor an appearance of confusion which a longer occupancy would doubtless remove. The Gates crusher is a round machine, and is produced almost wholly by the lathe and boring mill. The boring mills stand along the south side of the main floor, as shown in Fig. 8, and the principal lathes stand in two lines close together back to back, in the middle of the room, the countershafts being carried on a wooden structure supported by a single row of iron columns, as shown with tolerable clearness in Fig. 7. The line shaft from which these countershafts are driven by nearly vertical belts, passes through openings in the bases of these countershaft supporting columns near the floor level line. The disposition of tools on the floor is such that no picture could be taken which clearly showed this line shaft. Fig. 7 shows the general construction plainly enough, however, to be understood in connection with this description. The line of countershaft support is carried wholly by the iron columns mentioned, and its top view is given in Fig. 2, at the left-hand side.

The boring mill countershafts are carried on wooden brackets secured to an edgewise string piece, bolted flat against the beams of the south wall, as shown in Fig. 2.

Fig. 4.

Fig. 5.

THE GATES SHOPS.

Literary Notes.

THE MODERN MACHINIST. A Practical Treatise on Modern Machine Shop Methods. By John T. Usher.

The author of this book is quite well-known to our readers, his articles on "Rubber Pattern Making" and other subjects pertaining to practical mechanical operations, published in our columns, having attracted considerable attention. Some of the matter in the book before us has been published in our columns and a portion of the engravings will be familiar to our readers.

Only a small proportion of the whole book has thus appeared, however, and the whole of it is devoted to the illustration of new or little known machine-shop devices, nearly all of which are within the easy reach of those who have the regular standard machine-shop equipment with which to make and use them, and nearly all of which will help in doing better or lower cost work.

We do not think that the skilled and high-

ly-trained tool maker will find many things in the book that he will consider beyond improvement, and, in fact, the author does not pretend so much, but merely presents the various devices as being a record of actual practice in various shops, and as such the book will undoubtedly prove very useful to many machinists and others, especially those who are able to choose, adapt and modify intelligently.

Here and there we note things we should not care to use in the precise form in which they are shown—among them the double-spindle milling arrangement by which lathe beds are roughed out and finished simultaneously by milling—an operation which we have previously expressed our opinion on, and on page 255 a device for turning irregular forms in the lathe which undoubtedly has its counterweight misplaced; a similar device on page 253 having no counterweight at all, though one should be attached to the *tool block* in using all such devices. The book as a whole fully justifies itself, and there are thousands of shops in which it should be studied.

It is 5½ inches by 8 inches, neatly bound in cloth, and has 320 pages and 250 illustrations. It is published by Norman W. Henley & Co., 132 Nassau street, New York. Price, $2.50.

GARDENIER'S READY HELP FOR LOCOMOTIVE ENGINEERS. By Norman Gardenier.

This book of 117 pages, including an index, contains questions and answers relating to the running and care of locomotives. In the introduction to the book we are informed that the questions and answers have been arranged systematically in the same language that railroad men talk to each other. There is no doubt that the author has adopted the language used by some of the engineers, but not always of the most intelligent ones; the consequence is that many of the answers are misleading, to say the least. The book, of course, has its merits, but before it is placed in the hands of locomotive engineers it should be thoroughly revised. A few questions and answers will to some extent show the character of the book. "How does the locomotive get her steam? *A.*—By opening the throttle valve." This in one sense is true enough, but is trivial. "*Q.*—When the engine is given steam what part of the engine moves first? *A.*—The piston." We would like to know what becomes of the piston rod, crosshead, etc., firmly attached to the piston while the latter is moving? "*Q.*—At what points is the weight of the engine carried? *A.*—At the fulcrum of the equalizer beams." Here again we ask: What becomes of the front support of the engine? "*Q.*—How can you discover when the follower bolts are loose? *A.*—Cylinder heads would be knocked out." It seems to us that this is rather late to make the discovery, and, besides, loose follower bolts are not always the cause of knocking out cylinder heads. Other questions and answers of a similar character could be quoted, but the above are sufficient to justify our recommendation of a thorough revision of the book. It is published by Edward Meeks, Philadelphia, Pa. Price, $1.00.

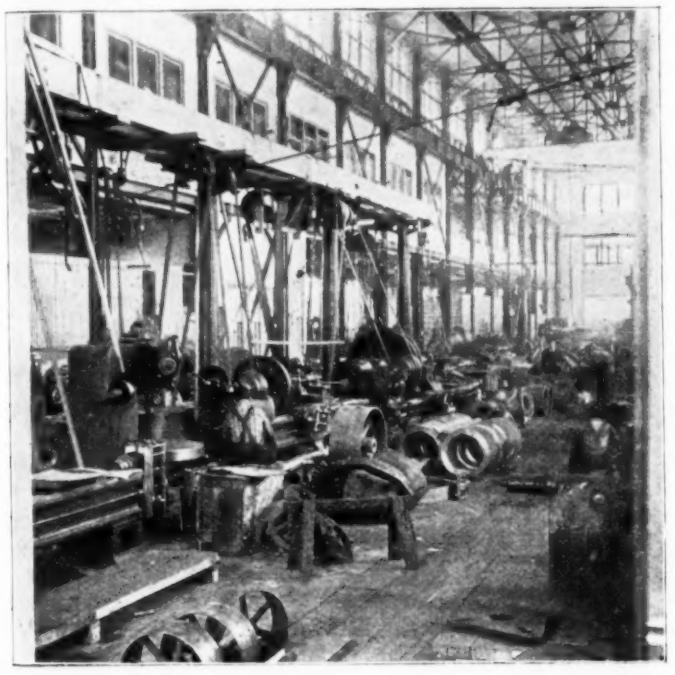


Fig. 7.

THE GATES SHOPS.

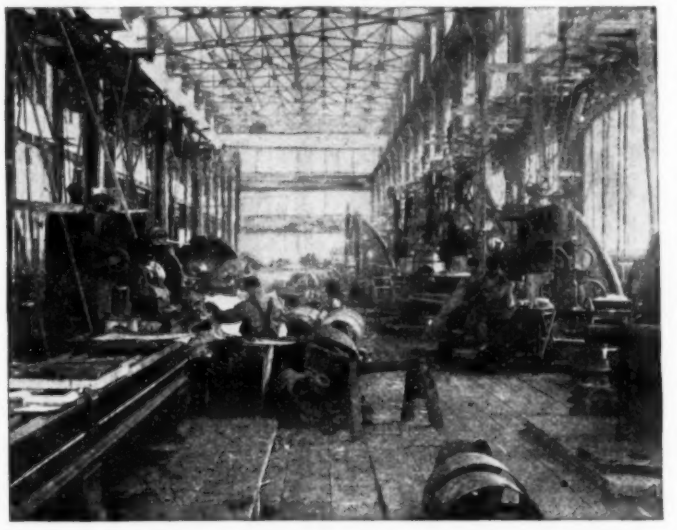


Fig. 8.

We have received a pamphlet of 52 pages treating on problems relating to aeronautics with criticisms of their solutions and practical applications, by E. Manfai, engineer. The author treats the subject from the standpoint of an engineer, and points out the difficulties which must be overcome before aerial navigation can be brought to a successful and practical consummation. The pamphlet is written in German, and will undoubtedly prove to be interesting and instructive to those who are interested in this science. It is published by Spielhagen & Schurich, Vienna, Austria. Price not given.

A New Nut-locking Device.

We present herewith illustrations of a new nut-locking device which is something of a novelty in its line, and is certainly interesting mechanically, since it enables an ordinary nut so loose on the bolt as to be readily turned on by the fingers, to tighten itself and hold its position, even under very trying circumstances, and that without adding to the weight of bolt or nut, or requiring additional room. The outline views, Fig. 1, show its construction. *A* is a locking segment which is threaded on its cylindrical surface to fit the nut, and is capable of rocking slightly about an axis *C*, which is in line with the axis of the bolt. When the nut is turned in the direction indicated by the arrow, *i. e.*, to screw it onto the bolt, the segment *A* assumes the position shown, and the nut screws on the same as on an ordinary bolt; but the least movement in the other direction tends to rock the segment in the same direction and to close up the opening shown; and, when this rocking to the amount allowed by the play in the threads has taken place, no further backing off can occur. When it is desired to remove the nut, it is easily accomplished by simply preventing the segment from rocking, and this is done by any simple means, such as inserting a piece of wire or even a small stick in the opening at the end of the bolt, thus preventing the rocking of the segment. It will be seen that the action is essentially that of a friction ratchet.

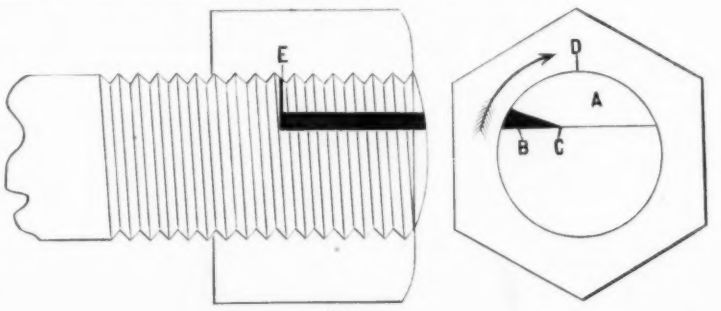
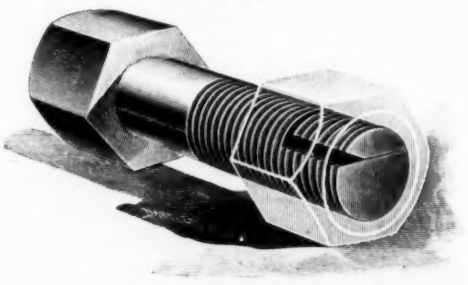


Fig. 1.



NUT-LOCKING DEVICE.

By altering the location of the fulcrum, or rocking point, with relation to the center of the bolt, the lock is made more or less positive in action, as may be desired to suit different conditions.

For track bolts, the proportions are such that the nut can be taken off with a wrench, but it is absolutely unaffected by vibration.

We have examined some of these bolts and have been much interested in their behavior. One of the most interesting tests of them, perhaps, is illustrated by Fig. 2, where an ordinary bolt and this locking bolt are joined by a piece of cord in the manner shown. In the upper view the common bolt is at the right, with its nut fully screwed on; the new bolt is at the left with its nut barely started on. The two bolts are then violently shaken by the hand of the operator, the bolts and nuts, of course, striking together frequently and at almost every possible point. After a few minutes of this shaking and knocking together, the nut of the common bolt invariably falls off, while the other has ascended its bolt, and will usually be found fully screwed on.

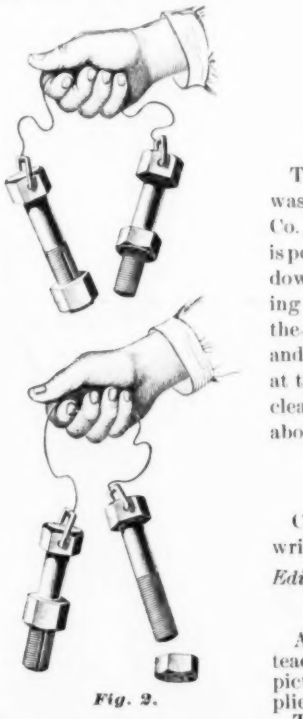


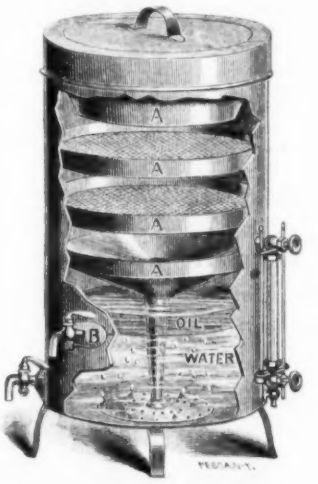
Fig. 2.

The reason for this phenomenon evidently is that the nuts each receive about an equal number of blows or impulses tending to rotate them upon their respective bolts; those which tend to run the nut off from the common bolt are assisted by gravity, while those with an opposite tendency are opposed by gravity. The former are therefore most effective, and the net result is a screwing off. With the other nut, however, only those impulses or blows tending to screw it on can have effect, those with the opposite tendency being resisted by the locking segment; with the result as shown. It is evident from this that the locking action must be exceedingly prompt.

An analogous result was obtained in a test made with a drop hammer; one of these bolts being put into a place where it had been found practically impossible to keep the common bolt and nut tight. The nut on the new bolt was purposely slacked off, and in every case was found screwed up tight after using the hammer for a short time.

In regard to strength, it is to be remembered that the common proportions of nuts and bolts give great excess strength in the threads, and tests made at the Watertown arsenal show that these bolts are uniformly pulled in two by the nut when screwed one thread over the point *E*, Fig. 1; the position in use being about as indicated by this figure.

Special machinery for manufacturing these bolts has been constructed, the segment pieces being rolled in long strips and afterwards cut up into suitable lengths. The bolts are made by the Vibration Proof Nut Co., 155 West 29th street, New York.



Robertson's Waste Oil Filter.

The accompanying illustration shows a waste oil filter made by Hine & Robertson Co., 61 Cortlandt street, New York. The oil is poured in at the top of the tank and passes down through the successive movable filtering trays and cloths *A*, *A*, *A*, and then down the vertical pipe to the bottom of the vessel and up through the water, and is drawn off at the faucet *B*. The apparatus is said to cleanse the oil effectively. Its capacity is about 15 gallons.

The Engineers in Detroit.

CHAS. A. STRELINGER & CO., of Detroit, write us as follows:

Editor American Machinist:

A. S. M. E. "OFF FOR DETROIT."

A school-boy was once asked by his teacher if he could draw "on his slate" a picture of a train of cars, to which he replied he could.

Teacher (to boy).—Draw such a picture and bring it to me when you have finished same.

Picture is finished and brought to teacher who said, "Why, Johnny, I thought you were going to draw the picture of a train of cars; this is only the engine."

Boy (to teacher).—I thought I would draw

the engine, then let the engine draw the cars.

With us we do not expect to draw the engine nor the cars, but we are here on the spot, and wish to extend an invitation through your columns to the A. S. M. E. (who are to visit our city June 25th to 28th), to make our store headquarters while here. All mail will be carefully attended to. We have at their disposal desk room and writing material. We have a very beautiful city surrounded with numerous places for a day's outing, and shall try to be of some assistance in directing all in search of pleasure trips, either by rail or boat.

Hoping some of your staff will be with us at this time, we beg to remain,

Yours truly,

Chas. A. Strelinger & Co.

Prof. Frederic R. Honey, of Yale College, who is well-known to American Machinist readers, sailed for Europe on the 15th, and will spend his vacation there.

NEW CATALOGS.

The Nordberg Mfg. Co., Milwaukee, Wis., send us a catalog illustrating and describing their improved Nordberg Corliss engine. This contains half-tone and other engravings, with description of details and full information. Independent condensers, both belt and steam-driven, are also illustrated. This catalog is 6¾"x10".

We have received from the Gibbs Electric Co., Milwaukee, Wis., a pamphlet, entitled "Light and Power." It is devoted to the illustration and description of multipolar dynamos and motors, which are manufactured by the above-named company, and many interesting details and points of information are given. It is standard size, 6"x9". We have also received from the same company "Bulletin 4," which is devoted to the illustration and description of Type "F" flexible suspension motors.

The E. M. Link Machinery Co., Erie, Pa., send us a "Sectional Catalog," illustrating and describing heating and ventilating apparatus for private houses, shops and public buildings. This consists essentially of the hot blast system, in which air taken from out-doors is forced by a fan over heated pipes, and then into the rooms to be warmed. Improved automatic feed pumps and steam traps are also illustrated and described, and there are various forms of steam engines, horizontal and vertical. Drawings showing the arrangement of several typical heating plants are given, and the catalog contains much useful information regarding the subject of heating and ventilation. It is 6¾"x10".

MANUFACTURES

The Monrovia Electrical Power Co., of Los Angeles, Cal., has been incorporated, with a capital of $100,000.

The Springer Electric Co., of McCordsville, Ind., was recently organized by T. L. Springer and A. C. Morrison.

The Blacksburg (Va.) Cotton Mill Co. has been organized, and will shortly erect a plant. Its capital is $150,000.

At Ashland, Ky., the Norton Iron Works will build a new heating furnace, and equip it with modern machinery.

The Illinois Rolling Stock Co., of East St. Louis, Mo., has been incorporated by Edw. S. Robert, with a capital of $300,000.

The Finished Steel Co., of Youngstown, Ohio, has been incorporated, with a capital of $100,000. Among the incorporators is C. Seymour Dutton.

The Haugh & Noelke Iron Works, of Indianapolis, Ind., were organized, with a capital of $50,000. The incorporators are Benjamin F. Haugh and Fred Noelke.

The new firm of McDowell, Stocker & Co., 61 S. Canal street, Chicago, has secured the Western agency of the Diamond Machine Co., of Providence, and of Wm. Whitlock, manufacturer of the National chuck.

Last week, in speaking of the new twist drill business of the Kearney & Foot Co., we inadvertently located that company in Newark, N. J. The office of this company is at 102 Reade street, New York, its factory being at Paterson, N. J.

It is announced that Mr. E. W. Bliss, who is at the head of the E. W. Bliss Co., and of the U. S. Projectile Co., of Brooklyn, N. Y., will remove from that city, and will sever his connection with several other corporations, retaining, however, for the present, his connection with the two companies named.

The Berlin Iron Bridge Co., of East Berlin, Conn., are the engineers and architects for the large three-story building which the Union Metallic Cartridge Co. are now putting up, at Bridgeport, Conn. The entire frame work of the building will be of steel, with brick walls, and all appliances for making the construction as nearly fireproof as possible.

The Whitman Mills Corporation was organized at New Bedford, Mass., recently. The plant to be built will be the largest mill ever instituted in New Bedford. The capital stock is $700,000. The officers are F. R. Hadley, president, and C. C. Dimon, treasurer. The directors are Edgar Harding, G. E. Driggs, S. W. Hayes, H. M. Knowlton, W. E. Brownell, L. E. Bentley, and H. A. Holcomb.

The Gilbert & Barker Mfg. Co., 82 John street, New York, are making a water heater, which consists of a coil of pipe inclosed in a small gas furnace, so arranged that the action of drawing water, automatically turns on the gas, and thus heats the water as it flows through the pipes. It is stated that this heater will deliver water at the rate of a gallon a minute at a temperature 80 degrees higher than that at which it is delivered to the heater, or it will deliver a less amount at a higher temperature, or a greater amount at a lower temperature, as may be determined by regulating the flow.

The Detrick & Harvey Machine Co., of Baltimore, Md, have just received an order from the Watertown Arsenal, Watertown, Mass., for an open side extension planer, which, when completed, will be one of the largest in the country. This tool is to be an exact duplicate of one which has been in operation at the Arsenal for about two years. It will plane 96 inches high, 132 inches wide, and 24 feet long, and will weigh about 150,000 pounds. The large post of this planer is 13½ feet high, 7 feet 3½ inches wide, and 2 feet 8½ inches thick. A very good idea as to the possibilities and capacity of the open side planer can be formed when it is known that this single piece, weighing about 20,000 pounds, was planed all over on a 42-inch open side planer.

Machinists' Supplies and Iron.

New York, June 15, 1895.

Iron—American Pig—We quote standard brands, $12 50 to $12.75 for No. 1; $11.50 to $11.75 for No. 2, and $10.75 to $11.00 for No 2 Plain. Southern brands, $12.25 to $12.50 for No. 1; $11.50 to $11.75 for No. 2; $11.25 to $11.50 for No. 3; $11.00 to $11.75 for No. 1 soft; $11.25 to $11.50 for No. 2 soft; and Foundry No. 4, $10.75 to $11.00.

Antimony—The market is firm, but practically no change in prices. We quote L. X., 8½c. to 8¾c.; Cookson's, 8½c. to 8¾c.; Hallett's, 7½c. to 7.15c.; U. S. French Star, 7½c., and Japanese, 7c to 7¼c.

Lard Oil—Prime City we quote at 52c. to 53c.

Copper—The market is quiet, but firm. Lake Copper has been selling at 10¾c. The demand of Casting Copper is fair at 10c.

Lead—The market is quiet, and the demand is small. For New York delivery 3 30c. is quoted.

Spelter—The market is active, and producers are holding out for better prices. For New York delivery 3.75c is quoted.

Tin—The market remains unchanged. For spot 14 25c. cash is quoted.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Toolmaker, of 24 years' exp., desires pos., with a chance to invest about $3,000. Box 26, Am. Mach.

Wanted—By a draftsman in mill engineer's office, a place with some mfg. concern; familiar with machine details and design. Box 16, Am. Mach.

Wanted—A situation as foreman in a jobbing foundry; 20 years' experience; the best of reference. Address P. H. Spaid, Rochester Post-office.

An A1 designer and draftsman, with technical education, and 8 years' prac. exp., is open for immediate engagement. Box 22, Williamsville, N. Y.

Wanted—Position as layer out in boiler shop. Best of reference. Address D., care of American Machinist.

Wanted—Thorough mechanic, with necessary executive and practical experience, to superintend a bicycle factory. Address Box 25, Am. Mach.

An experienced molder, who is a first iron mixer, wants position of foreman in shop where chilled iron castings are a specialty. Address Molder, American Machinist.

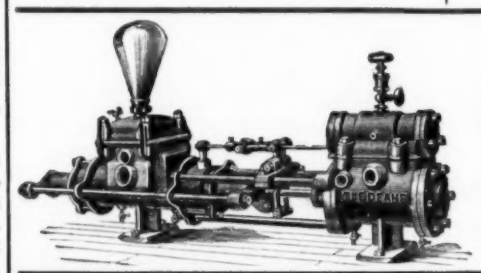
Wanted—By a manufacturer, an up-to-date draftsman on iron machine tools, especially drill press and boring-mill work. Address, with reference, and salary expected, Tools, care American Machinist, 203 Broadway, New York.

Wanted—Position by live, energetic mechanic of 20 yrs. exp., thoroughly up in modern methods of doing work; excellent draftsman and designer. Held positions as foreman, asst. supt. and chief draftsman, with large mfg. firms. O. P., Am. Mach.

Wanted—Superintendent and mechanical engineer; one thoroughly capable in designing Corliss engines of all kinds and the handling of 300 men; an experienced man only. Address, with references, A. B. C., care of American Machinist.

Wanted—An energetic foreman of a bridge mfg. company's machine shop. Should be familiar with bridge work, machinery of plant, and capable of general repairs. State age, experience and salary expected. Plant is a large one, and good salary paid to competent man. X. Y., Am. Machinist.

(*Continued on Page* 493.)



THE DEANE
OF HOLYOKE
BOILER FEED PUMPS,
PISTON OR PLUNGER PATTERN.
THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
SEND FOR "THE DEANE SPECIALTIES."

Crescent Steel Co.
Crescent Extra
. . IS . .
The Steel so generally used now for Machine Shop Tools.
PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.

Superior Quality of Tapper Taps.
ADJUSTABLE PLATE AND MACHINE DIES.
"Lightning" and "Green River" Screw Plates, Tap Wrenches, Reamers, Bolt Cutters, Drilling Machines, etc. Send for Catalogue.

WILEY & RUSSELL MFG. CO., Greenfield, Mass., U. S. A.

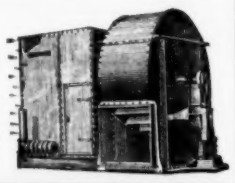
BUFFALO VENTILATING FANS
ELECTRIC, STEAM AND PULLEY TYPES. GREATEST AIR VOLUME, LEAST POWER
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.
Chicago Office, 22 and 24 West Randolph Street.
PROGRESSIVE AND APARTMENT TYPES
BUFFALO LUMBER DRY KILNS.
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

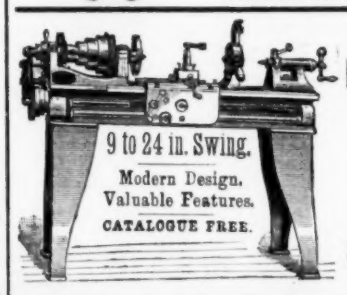
"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
Sole Representatives in the United States.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

THE MECHANICAL ENGINEERS' POCKET BOOK.
A Reference Book of Rules, Tables, Data and Formulæ, for the use of Engineers, Mechanics and Students.
By WILLIAM KENT, A.M., M.E.
Consulting Engineer, Member American Society Mechanical Engineers and American Institute Mining Engineers.
1100 Pages, 12mo, Morocco Flap. $5.00.
JOHN WILEY & SONS, - - - - - - - NEW YORK.

GRANT GEARS
Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.,
and 86 Seneca St.,
Cleveland Ohio.

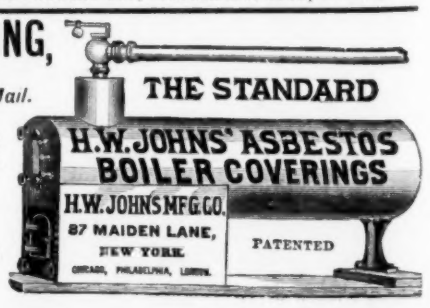
BEVEL GEARS,
Cut Theoretically Correct.
Special facilities for cutting worm wheels.
HUGO BILGRAM,
MACHINIST,
440 N. 12th St., Philadelphia, Pa.

HEAT YOUR WORKS
BY THE
"BLOWER SYSTEM."
FOR FULL INFORMATION AND ESTIMATES ADDRESS
B. F. STURTEVANT COMPANY,
Boston, New York, Philadelphia, Chicago, London, Eng.




FOUR POINTS ? ? ? ?
DESIGN? WORKMANSHIP? MATERIAL? FINISH?
All these are comprised in the make-up of our lathes and are the four necessary points in the construction of a good tool. Add to these a FIFTH and a very important one, the price, which we make very low to prompt cash buyers, and you have the story.
Our catalogue will tell you all about our lathes, planers, shapers, etc. We will be glad to hear from you.
SEBASTIAN LATHE CO.,
117 & 119 CULVERT ST., CINCINNATI, OHIO, U. S. A.

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.
87 Maiden Lane, NEW YORK.


WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Foreman wanted for a machine shop not far from Chicago. About 150 men employed on medium heavy work. Modern equipment and methods. Good salary and permanent position for a thoroughly competent man. Address Box 21, AMERICAN MACHINIST.

Comp. man solicits correspondence with parties in need of an assistant superintendent or chief draftsman. Experienced in water wheels, gearing, heavy power transmission, paper and pulp mill machinery, and steam pumping machinery; 15 years' experience. Address A. D. H., AM. MACH.

Wanted—A position where a thorough knowledge of dies and diemaking will be of value to my employers. At present am foreman of 50 men on this class of work, specialty, the making of dies by the piece-work system. A. P. Press, care AMERICAN MACHINIST.

Superintendent Wanted—To take charge of a brass shop; one who is acquainted with the melting of metals, and the manufacture of all kinds of valves, cocks, etc., for steam, gas and water service. Only first-class man need apply. State age, experience and salary expected. Box 23, AMERICAN MACHINIST.

Practical mechanical engineer, age, 29, now superintendent of the machine shops and drafting room of a leading New England concern, would like to correspond with parties needing a thoroughly up-to-date man, who can design and build high-grade machinery at low cost. Address Box 27, AMERICAN MACHINIST.

A general manager wanted for a steam engine and dynamo-electric manufacturing establishment; must have experience, energy and executive ability, and be able to put some capital into the business; a modern plant, located near New York, costing over $200,000; a "going concern," with abundance of profitable orders already secured, offers unusual inducements for capital and experience. Address, giving experience and references, F. J. K., Post Office Drawer 171, Buffalo, N. Y.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

Bicycle Repair Outfit. Send 6 cents postage for full illus. catalog. Frasse, 17 Warren St., New York.

For Sale—An 8x8x7 duplex Clayton air compressor nearly new. Compressor, AM. MACHINIST.

Wanted—Partner with $20,000 to mfr. gas engines pat'd. J. Werschmidt, 34 Kenwood St., Cleveland, O.

For Sale—Second hand planer, also lathes. Gage Machine Works, Waterford, N. Y.

Wanted—To buy, screw machine 1¾" to 2", hollow spindle pref'd. The Scanlan Co., Portland, Me.

Gas eng. patentee wants mfr. to handle eng. thor'ly understands the bus.; would take charge; several in use. Machinist, Box 24, AM. MACHINIST.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

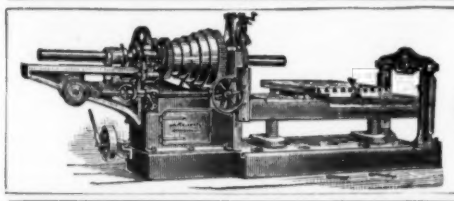
For sale or rent—Machine business in New England town; foundry and pattern shop adjoining. Reason for selling, poor health of proprietor. Address "L.," AMERICAN MACHINIST.

Very valuable patent for sale, of March 26, 1895, No. 536,306, covering single sheared and gang ploughs; price reasonable. Address M. Weber, Room 27, Wood Building, New York.

A permanent situa'n in Lancashire (Eng.) is open for a manager in a small toolmaking establishm't employing 150 men; experience in the systematic management of work and men required. Reference given to applicant conversant with mass product'n upon the American system. Write, stating salary required, to T. T., Box P., 52,352 Smith's Advertising Agency, 132 Fleet street, London, E. C. England.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

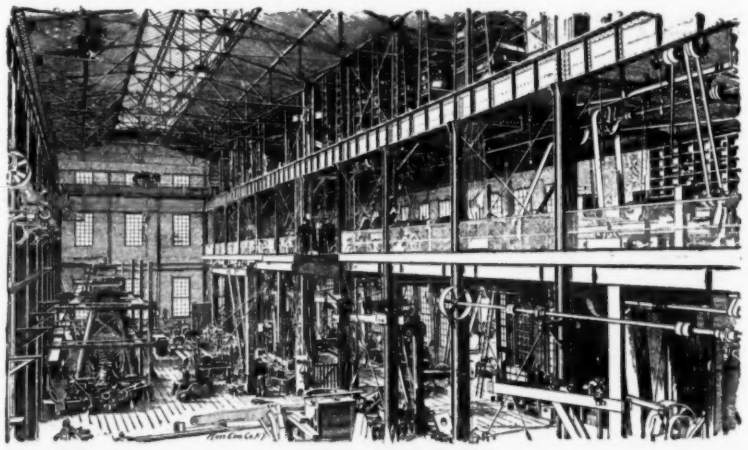
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



BETTS MACHINE CO.,
WILMINGTON, DEL.
MACHINE TOOL BUILDERS.
Improved Patterns! Late Designs!

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of



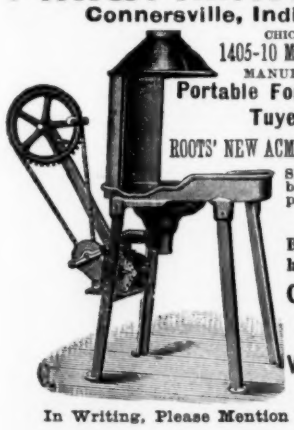
Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the interior of a Machine Shop designed and built by us for The Dry Dock Engine Co., at Detroit, Mich. The central portion, or Erecting Room, is 40 feet wide, with a gallery three stories high on one side, this gallery being 27 feet in width. The upper floor of the gallery is used for storing patterns, while the second floor is used for light machine work and the lower floor for heavy machine work—this lower floor being controlled by jib cranes, which also swing out into the central portion, thus delivering material from the wings by the means of jib cranes and the traveling crane to any portion of the Erecting Room. The whole framework of the building is of Iron, with brick filling for the side walls.

SEND FOR OUR ILLUSTRATED CATALOGUE.

The National Machinery Company,
TIFFIN, OHIO,
are in the market for one 8 x 8, 18 ft., second-hand planer, 4 head. Must be in first-class condition.

P.H.&F.M.ROOTS,
Connersville, Indiana.
CHICAGO OFFICE:
1405-10 Manhattan Building.
MANUFACTURERS OF
Portable Forges,
Tuyere Irons, Etc.
ROOTS' NEW ACME HAND BLOWERS,



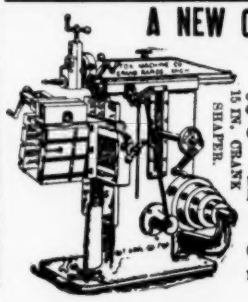
Slow speeded, Force blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, Etc.
COOKE & CO.
Selling Agents,
163 and 165 Washington St.,
NEW YORK.
In Writing, Please Mention This Paper.

CENTER GRINDERS,
WILLIAM BARKER & CO., Mfrs.,
IRON AND BRASS WORKING MACHINERY,
CINCINNATI, OHIO.

TELESCOPES
SEND FOR CATALOGUE
W. & D. MOGEY.
45TH ST. BAYONNE N.J.

HENRY CAREY BAIRD & CO.,
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England.

POWER OR HAND PLANER,
FOR MODEL MAKERS, EXPERIMENTAL WORK, &c.
Has all the Improved Features Usually Found on High Grade Planers, and is Capable of Doing the Best and Finest Work.

MANUFACTURED BY
A. J. WILKINSON & CO.,
184 Washington Street, Boston, Mass.

Star Foot-power Screw Cutting Automatic Cross Feed Lathes
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N. Y.

CALIPER SQUARES
Any Style or Graduation.
5 Sizes, Metric and Vernier System.
WARRANTED ACCURATE.
Send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

C. W. LE COUNT,
SOUTH NORWALK, CONN.

REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.60
4	3-4	.80
5	7-8	.90
6	1	.70
7	1 1-8	.80
8	1 1-4	.85
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$31.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

This Dog has a Very Heavy Base, so that if the thread wears a Heavier Screw can be substituted.

When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.

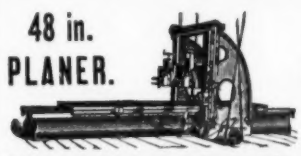
Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.

One Small Set of 8—by 1-4 inches to 20 inch, - - $6.25
One Set of 12—by 1-4 in. to 2 in. continued by 1 2 in. to 4 in. 13.25
These goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

STRANGE, BUT TRUE!!
THE NEW PROCESS RAW HIDE GEARS
ASTONISH THE
MACHINERY WORLD.

They Outwear any Metal.
They require No Lubricant.
They are Noiseless and Clean.
NEW PROCESS RAW HIDE CO.,
PATENTEES AND SOLE MANUFACTURERS,
SYRACUSE, N. Y., U. S. A.

FITCHBURG TOOLS.



48 in. PLANER.
WE MAKE IT OUR AIM
To produce only tools which will give you the greatest return in QUALITY and QUANTITY.
Look at our Machines before you place your order. It cannot hurt you and may BENEFIT US BOTH.
Catalog E furnished you.
FITCHBURG MACHINE WORKS,
FITCHBURG, MASS.

BUILDERS IRON FOUNDRY,
FOUNDERS AND MACHINISTS,
PROVIDENCE, R. I.
We can guarantee that our castings will be uniform and of high tensile strength.
Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "

JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

BOHLER'S STYRIAN TOOL STEELS.
First Quality for Shop Tools.
Extra Quality for Expensive Tools.
Special for Boring and Turning Hard Metals.
"BOREAS" SELF-HARDENING.
HOUGHTON & RICHARDS, SOLE AMERICAN AGENTS,
148 & 150 Oliver Street, BOSTON.

WORTHINGTON CONDENSER.
ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St. BOSTON, 70 Kilby St. PHILADELPHIA, 607 Arch St. CLEVELAND, 24 South Water St. CHICAGO, 185 to 189 Van Buren St. ST. LOUIS, Eighth and St. Charles Sts. INDIANAPOLIS, 64 South Pennsylvania St.

Established in 1874.

CLEVELAND TWIST DRILL CO.

COR. LAKE & KIRTLAND STS. CLEVELAND, O.

99 Reade Street, New York.
85 Queen Victoria St., London, Eng.
5 Neue Promenade, Berlin, C., Germany.

NEW AND SECOND-HAND MACHINERY.

ENGINE LATHES.

13 in. x 6 ft. Blaisdell.
14 " x 6 " Flather.
16 " x 6 " Blaisdell.
15 " x 6 " Standard.
15 " x 8 " Standard.
18 " x 8 " Fitchburg.
20 " x 8 " Pond.
20 " x 10 " Putnam.
20 " x 8 " Prentiss.
24 " x 12 " New Haven.
24 " x 10 " Standard.
24 " x 22 " Perkins
28 " x 16 " Fay & Scott.
30 " x 26 " with Shaft'g atts.
32 " x 16 " Waterman.
35 " x 15 " Hewes & Phillips.
72 " x 20 " Union.

DRILLS.

Sensitive Drills, Improved.
24 in. Bk. Gd. Auto. Fd. Prentiss.
28 in. Back Geared, Blaisdell.
Radials, 3, 4 and 5 ft. Arms.

HOR. BORING & DRILLING MACHINES.

Sellers, 54 in. swing, complete.
Bement, 54 in. swing, No. 2.
Cyl. Borer 12 to 36 in. cyls.

PLANERS.

22 in. x 4 ft. Pond.
24 " x 4 " Wood & Light.
24 " x 5 " New Haven.
24 " x 6 " Rochester.
30 " x 7 " Pond.
30 " x 10 " Harrington.
42 " x 12 " Gleason.

SHAPERS.

8 in. Stroke, Crank Motion.
15 " " " "Gould & E.
16 " " " "Prentiss.
16 " " " "Standard.
14 " " Trav. Head, with centers, circular feed, Fitchb'g.

SLOTTERS.

10 in. Stroke, Lowell.
18 " " Bement.

BOILER ROLLS.

7½ and 8 ft. Good order.
8 and 10 ft. New Improved.

SCREW MACHINES.

P. & W. No. 2 Wire Feed.
Brown & Sharpe No. 5, complete.

MILLING MACHINES.

P. & W. No. 2 Hand.
Garvin No. 3 Power Feed.
Lincoln Pattern with Vise.

Gray Planers "NEW," 22, 24, 30 and 36 in.
Kempsmith Millers, Universal and Plain.
Bardons & Oliver's Screw Machines, Improved Style.
Fitchburg Lathes, 14 to 72 in. Swing.

J. J. McCABE,

SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

SECOND-HAND MACHINERY.

BALLOU TOOL-ROOM LATHE, WITH CHUCKS.
BROWN & SHARPE UNIVERSAL MILLER, No. 1.
AMES TWO-SPINDLE PROFILER.
FERRACUTE DRAWING PRESS.
UNIVERSAL CUTTER AND REAMER GRINDER.
FOUR-SPINDLE POWER FEED DRILL.

The above Tools are as good as new.

PRENTISS TOOL & SUPPLY CO.,
62 & 64 So. Canal St., CHICAGO, Ill.

Rolling Mill.

MOSSBERG MFG. CO.,
ATTLEBORO, MASS.
MANUFACTURERS OF
SPECIAL MACHINERY,
Jewelers' and Silversmiths' Tools.
NEW IDEAS! NEW DESIGNS!

The following sizes of mills we keep in stock: 3 in. x 5 in., 3½ in. x 5 in., 4 in. x 6 in., 5 in. x 8 in. We also build to order 6 in. x 8 in., 8 in. x 12 in., 10 in. x 15 in., 12 in. x 18 in. Our rolling mills are fitted with the Mossberg roller bearing, which will save AT LEAST 50 PER CENT. OF THE POWER. No more trouble with hot journals. Write for particulars.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.

14 in. x 4 ft. Blaisdell, Taper.
16 in. x 6 ft. Perkins, Taper.
16 in. x 8 ft. Perkins, Taper.
16 in. x 8 ft. Blaisdell.
18 in. x 10 ft. Blaisdell.
28 in. x 20 ft. Perkins.
37 in. x 14 ft. maker unknown.

PLANERS.

16 in. x 16 in. x 4 ft. Hendey.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 5 ft. Putnam.

SHAPERS.

10 in. Pratt & Whitney.
12 in. Juengst, Crank.
15 in. Juengst Friction.
10 in. Wood and Light Traverse Head.
18 in. Putnam, Traverse Head.
18 in. Smith & Silk, Crank.
21 in. Smith & Silk, Shifting Belt.
20 in. Gould & Eberhardt.
24 in. Hendey, Friction.

DRILL PRESSES.

No. 1 Two Spindle, Garvin.
No. 2 Three Spindle, Garvin.

DRILL PRESSES.

No. 2 Four Spindle, Pratt & Whitney.
No. 3 Six Spindle, Garvin.
20 in. Snyder, Wheel Feed
24 in. Blaisdell Wheel Feed.
24 in. Aurora, Back Geared.
30 in. Pond, Back Geared, Power Feed.
9 ft. Holly Mfg. Co., Radial.

SCREW MACHINES.

No. 1 Garvin, Wire Feed.
No. 5 Brown & Sharpe.
2 No. 1 Brown & Sharpe, Wire Feed.
1 Brown & Sharpe Automatic.
No. 2¼ Pratt & Whitney.
No. 3 Garvin, Back Geared.

MILLING MACHINES.

No. 2 Pratt & Whitney, Lincoln.
1 No. 20 Garvin, with arm.
1 No. 21 Garvin, with arm.
No. 0 Garvin Universal.
No. 1 Garvin Universal.
No. 3 Garvin Lincoln.
No. 2 Garvin Duplex.

Also, a large number of other machines. Write for complete list, detailed description and prices.

THE GARVIN MACHINE CO.,
LAIGHT & CANAL STS., NEW YORK.
Also, 51 North 7th St., Philadelphia, Pa.

MACHINERY BARGAINS

BEFORE REMOVAL.

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
22 " x 12 " " "
29 " x 13½ " " "
26 " x 20 " " "
29 " x 12 " " "
37 " x 30 " " "
71 " x 18 " " "
52 " x 20 " " "

19-36 and 50 in. Drills.
Portable Drill.
24 in. x 5 ft. Planer.
36 in. x 14 ft. Planer.
12 in. Shaper Traverse Head.
Gear Cutter, 54 in.
Milling Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

Send for full list and prices.

GEORGE PLACE MACHINE CO.
145 Broadway and 86 Liberty St.,
NEW YORK.

SEND FOR CATALOGUE.

Manufacturers of Set, Cap & Machine Screws, Studs, etc.

MACHINERY FOR SALE.

9 x 9 Greenfield Upright Engine, good as new.
36 in. x 7 1-2 ft. Upright Boiler, good order.
Nos. 1, 5 and 6 Roots Blowers, A1 condition.
1-4 to 1 1-4 in. Open-die Bolt Cutter, good as new.
21 in. Gould & Eberhardt Drill, " " "
6 in. Boynton Hand Shaper, " " "
28 in. x 24 in. x 7 ft. New Haven Planer, new.
Lot 6 1-3 in. and 7 1-2 in. Hammered Steel Shafting, Bearings, Friction Clutch Pulleys, etc., less than half value.

COOKE & CO.,
163 and 165 Washington St., NEW YORK.

The Andrew Patent Grip Socket.

Patented May 14, 1889, and Sept. 4, 1894.

Is the original (not copied) device for holding and driving **The old system of Straight and Taper Shank Drills.** With **Andrew's Patent Inclined Groove** Milled in the Shank. **No more Twisted off Tangs.** Best Practical Drill Chuck in the World. **Beware of Frauds.** Infringements on these patents will be prosecuted. Send for Catalogue.

M. L. ANDREW & CO., Cincinnati, O

E. W. BLISS CO.

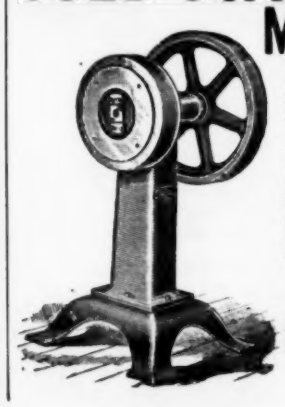
1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 100 W. Washington Street.

DRAWING, PUNCHING, TRIMMING AND DROP PRESSES.

DIES, SHEARS AND SPECIAL MACHINERY.

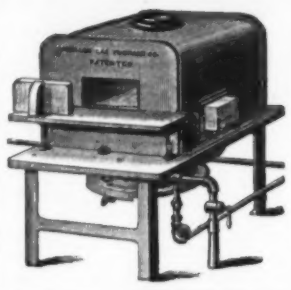
OWNERS OF
The STILES & PARKER PRESS CO.

COLD SWAGING MACHINE



The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

EXCELSIOR NEEDLE CO.
Torrington, Conn.



AMERICAN GAS FURNACE CO.,

Oil Gas Plants

GAS BLAST FURNACES AND HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau St., NEW YORK.

English Agency: { Chas. Churchill & Co., Ltd., 21 Cross St., Finsbury, London, E. C., England.

As Good As New.

One Large Planer.

Made by the Pond Machine Tool Co. Planes 54 in. square and 25 ft. long, with two heads on the cross rail. Will be sold at

A BARGAIN.

Must be sold and removed within **thirty days.**

HILL, CLARKE & CO.,
Machinery Merchants,
156 Oliver St., BOSTON.
12 & 14 S. Canal St., CHICAGO, Ill.

WANTED

TO BUY FOR CASH.

First-class Second-hand Engine Lathes, Planers, Drill Presses, Shapers, Milling Machines, etc., address,

The Fosdick & Plucker Machine Tool Co.,
CINCINNATI, OHIO.

FOR SALE.

PUNCHES and SHEARS.

Also a number of Punch and Shearing Machines, Small Rolls, etc. Write for prices. Address

WAIS & ROOS PUNCH AND SHEAR CO.,
CINCINNATI, OHIO.

A BONANZA in an

OIL CUP

is the Bonanza oil cup Works any side up.

BETTER LIGHTER STRONGER HANDIER CHEAPER THAN ANY COMPETITOR

Charles H. Besly & Co.
FINE TOOLS
SUPPLIES FOR MFRS. METAL WORKERS ETC.
Chicago, Ill. U.S.A.

MACHINE TOOLS.

IN FIRST-CLASS CONDITION.

16 in. F. B. Miles Slotting Machine.
2,400 Pound Miles Steam Hammer, Single Standard.
30 in. by 27 ft. Pratt & Whitney Engine Lathe.
Horizontal or Floor Boring Machine, Pratt & Whitney.
Two (2) 5 ft. Universal Radial Drills.
21 in. x 11 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
19 in. x 8 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
26 in. x 8 ft. Pond Machine Tool Co. Engine Lathe.
19 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle.
22 in. x 12 ft. Pratt & Whitney Engine Lathe, Hollow Spindle
21 in. x 11 ft. Lodge & Davis Engine Lathe, Hollow Spindle and Taper Attachment.
40 in. Bement Vertical Drilling Machine.
24 in. Pratt & Whitney Vertical Drilling Machine.

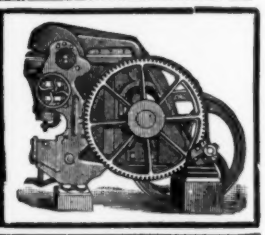
GEORGE PLACE MACHINE CO.,
145 Broadway & 86 Liberty St., New York.

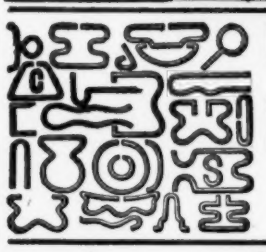
EMERY WHEELS.

The R. J. Costain New Process Emery and Corundum Wheels are the wheels you want. We require only two days in which to make and ship any grade of the regular sizes and style of wheel. Give us a trial. Satisfaction guaranteed or no sale.

The Electric Emery Wheel Co., Hartford, Conn.
Box No. 177. COSTAIN & EAVES.

PUNCHING AND SHEARING MACHINERY
AND BOILER MAKER'S ROLLS.
NEW DOTY MANUFACTURING CO.
JANESVILLE, WISCONSIN.





BLAKE & JOHNSON, Waterbury, Conn.

BUILDERS OF

PIN, SAFETY PIN, HOOK AND EYE MACHINERY,

AND LABOR-SAVING MACHINES OF EVERY DESCRIPTION.

Bent Wire Goods a Specialty. Send Samples that we may quote prices for either machine or the Goods.

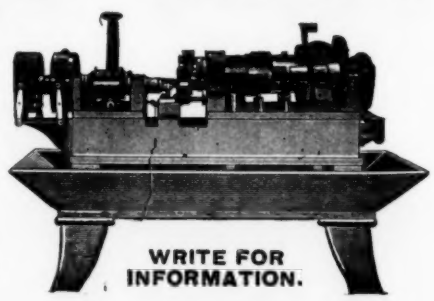
STEEL BALLS

For all Anti-Friction Purposes.

WE ALSO MANUFACTURE

AUTOMATIC SCREW MACHINES
AND
SCREW MACHINE PRODUCT
OF EVERY DESCRIPTION.

Cleveland Machine Screw Co.,
CLEVELAND, OHIO.



WRITE FOR INFORMATION.

THOS. H. DALLETT & CO.,

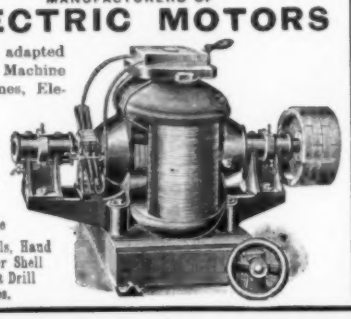
YORK ST. & SEDGLEY AVE., PHILADELPHIA.

MANUFACTURERS OF

ELECTRIC MOTORS

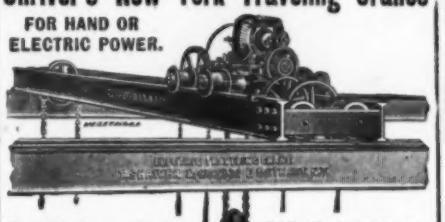
Specially adapted for driving Machine Tools, Cranes, Elevators, Pumps, Presses, and other Machinery.

We also make Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.



Shriver's New York Traveling Cranes

FOR HAND OR ELECTRIC POWER.



T. Shriver & Co. 333 East 56th St., NEW YORK.

MANUFACTURERS OF

TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or wholly or in part by Electricity.

IMPROVED INDEPENDENT CHUCK.

This cut represents a line of **Improved Independent Reversible Jaw Chucks** that we have lately added to our large list of Universal and Combination Chucks. We make this style of Chuck in **twenty-two sizes**, varying in size by two inches from **four** to **forty-two** inches in diameter. Send for Illustrated Price List.

THE E. HORTON & SON CO.,

WINDSOR LOCKS, CONN., U. S. A.

Or CHAS. CHURCHILL & CO., 21 Cross St., Finsbury, London, E. C., England.

"CUSHMAN" CHUCKS.

For Lathes, Drills, Chucking and Screw Machines, and for Special work. . . . . .

SEND FOR CATALOGUE.

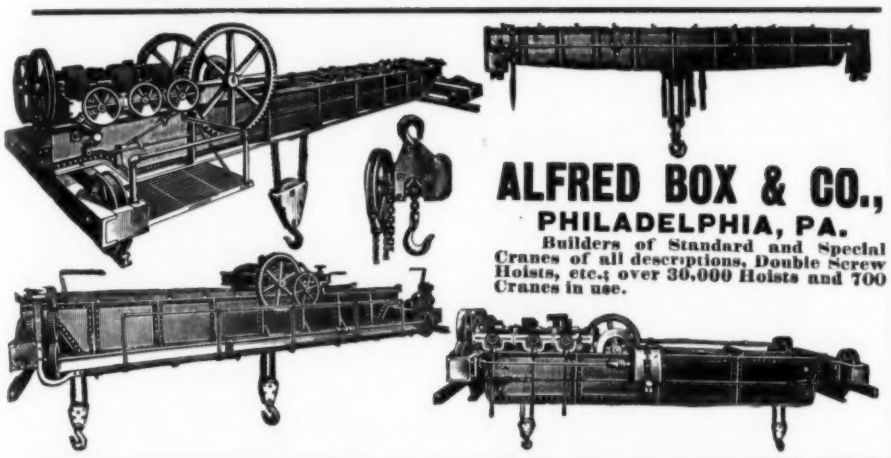
THE CUSHMAN CHUCK CO., HARTFORD, CONN.

EMERY WHEELS

NORTON Emery Wheel Co.

Worcester, Mass.

NEW COMPLETE ILLUSTRATED CATALOGUE FREE.



ALFRED BOX & CO.,

PHILADELPHIA, PA.

Builders of Standard and Special Cranes of all descriptions, Double Screw Hoists, etc.; over 30,000 Hoists and 700 Cranes in use.

FOR SALE: PLANER CHUCK BUSINESS.

For particulars address

G. W. JORDAN,

4 Wayne Street, WORCESTER, Mass.

PEQUOT DRILL CHUCK.

A new Drill Chuck having a more powerful grip than any chuck ever offered. This seems a broad claim, but we prove it to mechanics who will examine. Ask at your dealers or write us for particulars.

THE D. E. WHITON MACHINE CO.,

5 Oak Street, New London, Conn., U. S. A.,

OR, SELIG, SONNENTHAL & CO.,

85 Queen Victoria St., London, E. C., England.

Chucks

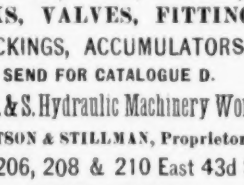
The National.

INDEPENDENT, UNIVERSAL, or COMBINATION.

Est'd 1882. Strongest. Easiest to change. Best finish. **Reversible Jaws** (patented) giving 5 changes including every possible position. ILLUSTRATED CATALOGUE sent. Liberal discounts. Prompt shipment. Address

W. WHITLOCK, 39 Cortlandt Street, N. Y.

Works, 1300 Hudson, Hoboken, N. J.



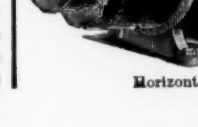
SKINNER CHUCKS.

Independent and Universal Chucks, Combination Lathe Chucks with patent reversible jaws, Drill Chucks, Planer Chucks and Face Plate Jaws.

SKINNER CHUCK CO.,

SEND FOR CATALOGUE. New Britain, Conn.

WE LEAD, OTHERS FOLLOW.



Sweetland Combination Chuck.

Reversible Jaws. Accurate. Standard Independent, Solid Shell, Solid Reversible Jaws, Strong and True.

SEND FOR CATALOGUE.

The HOGGSON & PETTIS MFG. CO., - New Haven, Conn.

PRATT'S Positive Driving Drill Chuck.

The best system ever devised for holding and driving drills.

WRITE FOR CATALOGUE TO

THE PRATT CHUCK CO., Clayville, N. Y.

Cranes

AIR HOISTS, CUPOLAS, Etc.,

Whiting Foundry Equipment Co.,

Send for Circulars. 1522 Monadnock, Chicago.

EVERY MACHINIST SHOULD HAVE A COPY OF

OUR CATALOGUE.

It is a 704 page cloth bound book. A copy will be sent, express paid, to any one sending $1.00, and the money paid for book will be refunded with first order amounting to $10.00 or over.

MONTGOMERY & CO.,

105 FULTON STREET, NEW YORK CITY.

QUINT'S TURRET DRILLS

For Drilling and Tapping with from 2 to 12 Spindles.

WILL DRILL UP TO ¾-INCH.

Sensitive and Positively Driven.

A. O. QUINT, Hartford, Conn.

THE PERKINS DRAW STROKE TRIMMER,

An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.

PERKINS & CO., Grand Rapids, Mich.

STOCKS, NEAVE & CO., Manchester, England.

TRAVELING CRANES

Capacity 20,000 lbs.

B. HARRINGTON, SON & CO., Inc.

1515 Penna. Ave., PHILA., PA.

SEND FOR CATALOGUE OF MACHINE TOOLS.

WILL HOLD LOAD AT ANY POINT

ARMSTRONG'S

Pipe Threading and Cutting-Off Machines.

Both Hand and Power.

Sizes 1 to 6 inches.

Water, Gas and Steam Fitters' Tools, Hinged Pipe Vises, Pipe Cutters, Stocks and Dies universally acknowledged to be THE BEST.

Send for Catalogue.

ARMSTRONG MFG. CO., Bridgeport, Conn.

WILSON IMPROVED IRON PLANERS.

STANDARD SIZES & KEPT IN STOCK.

W. A. WILSON, RIVER ST. ROCHESTER, N.Y.

HEAVY SLAB MILLING MACHINES.

Pat. Dec. 24, 1889.

REGULAR SIZES.

60	inch by	60	inch by	12	feet.
48	" "	48	" "	12	"
36	" "	36	" "	8	"
24	" "	24	" "	6	"
15	" "	15	" "	4	"

PATENT CUTTERS. SPECIAL MILLING MACHINES DESIGNED.

Write for full information, photographs and prices.

THE INGERSOLL MILLING MACHINE CO.,

ROCKFORD, ILLINOIS, U. S. A.

SOFT CASTINGS,

Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.

THE BURR & HOUSTON CO.,

33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

WOOD WORKING MACHINERY

OF EVERY KIND.

PRINTED MATTER ON APPLICATION.

THE EGAN CO.,

239-259 W. Front St., CINCINNATI, OHIO.

BACK VOLUMES OF THE AMERICAN MACHINIST

For any of the fourteen years, 1880 to 1894, inclusive, may still be obtained, but must be ordered soon, as our stock is nearly exhausted. Price unbound, $3.00 per volume postpaid. Bound in cloth, $4.00 per volume (purchaser paying freight or express charges). No separate back numbers prior to 1894 are now carried in stock. Only complete volumes furnished prior to 1894. Readers desiring to complete their files or obtain separate issues for the year 1894 are advised to order soon, before our limited reserve stock is exhausted.

AMERICAN MACHINIST, 203 Broadway, New York.

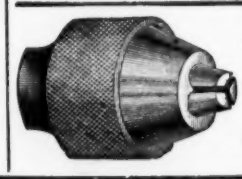
IF YOU WANT ANYTHING IN THE LINE OF DROP PRESSES · DROP HAMMERS · STAMPS OR AUTOMATIC DROP LIFTERS.

SEND FOR CATALOGUE TO

Miner & Peck Mfg. Co.

NEW HAVEN, CONN.

LARGEST LINE IN THE MARKET



Almond Drill Chuck.

Sold at all Machinists' Supply Stores.

T. R. ALMOND,

83 & 85 Washington St., BROOKLYN, N. Y.

Nuts!!

NOT "TO CRACK"

BUT **TO USE.**

TRUMP BROS. MACHINE CO., Mfrs.,

WILMINGTON, DEL.

SPEIDEL'S ECONOMIC SAFETY

HOISTS,

TRAVELING CRANES, OVERHEAD TRAMWAYS.

SPEIDEL & ROEPER,

READING, PA.

Send for Catalogue.

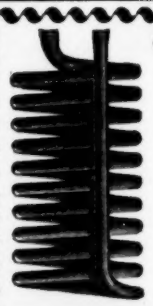
Dixon's Silica Graphite Paint

Will preserve a roof for TEN to FIFTEEN YEARS—perhaps longer, without repainting.

Unequaled for SMOKE STACKS, BOILER FRONTS, Etc.

Send for circulars on Paints and Painting.

JOS. DIXON CRUCIBLE CO., Jersey City, N. J.



COILS and BENDS of IRON, BRASS, and COPPER PIPE of every description.

The National Pipe Bending Co.

82 River St., New Haven, Conn.

HYDRAULIC MACHINERY.

Horizontal Jack.

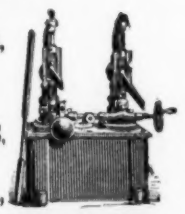
PRESSES, PUMPS, PUNCHES, JACKS, VALVES, FITTINGS, PACKINGS, ACCUMULATORS.

SEND FOR CATALOGUE D.

The W. & S. Hydraulic Machinery Works,

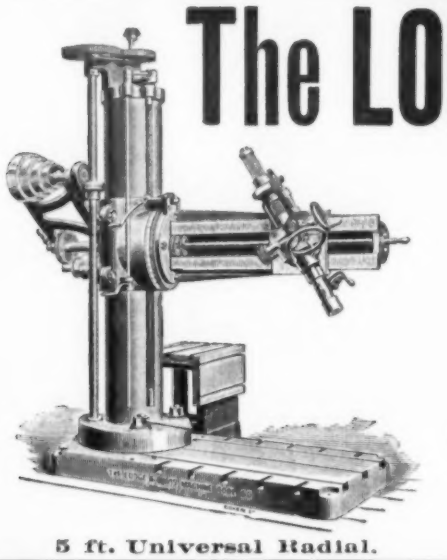
WATSON & STILLMAN, Proprietors,

204, 206, 208 & 210 East 43d St., NEW YORK.



2-Plunger Hand Pumps

The LODGE & DAVIS MACHINE TOOL CO.



5 ft. Universal Radial.

DESIGNERS AND BUILDERS OF

Plain and Universal Radial Drills, Upright Drills, Planers, Engine Lathes, Milling Machines, Screw Machines, Bolt Cutters, Shapers, Monitor Lathes, Pulley Lathes, Universal Cutter and Reamer Grinders, etc., etc.

Works: CINCINNATI, OHIO, U. S. A.

NEW YORK STORE, 110 Liberty Street.
CHICAGO STORE, 68-70 S. Canal Street.
BOSTON STORE, 36 Federal Street.
PHILADELPHIA STORE, 19 N. Seventh Street.
ST. LOUIS STORE, 720 N. Second Street.
COVENTRY, ENGLAND. Alfred Herbert, Agent.

Lathes

OUR PAT. RADIAL DRILLS ARE BEST.

Good tools produce good work, we use only the finest machinery and employ the most skilled Mechanics, hence, are in position to offer the best Mechanisms to be obtained at a moderate price.

ENGINE LATHES.

22" and 24" furnished in lengths of 8, 10, 12, 14, and 16 feet Bed.

With all modern Improvements.

Address,
Dietz, Schumacher & Co.,
Cincinnati, O., U. S. A.

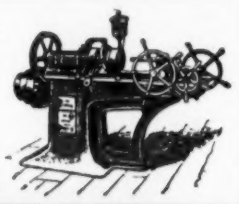
CHUCKING LATHES

THE LODGE & SHIPLEY M. T. CO.,

CINCINNATI, O., U. S. A.

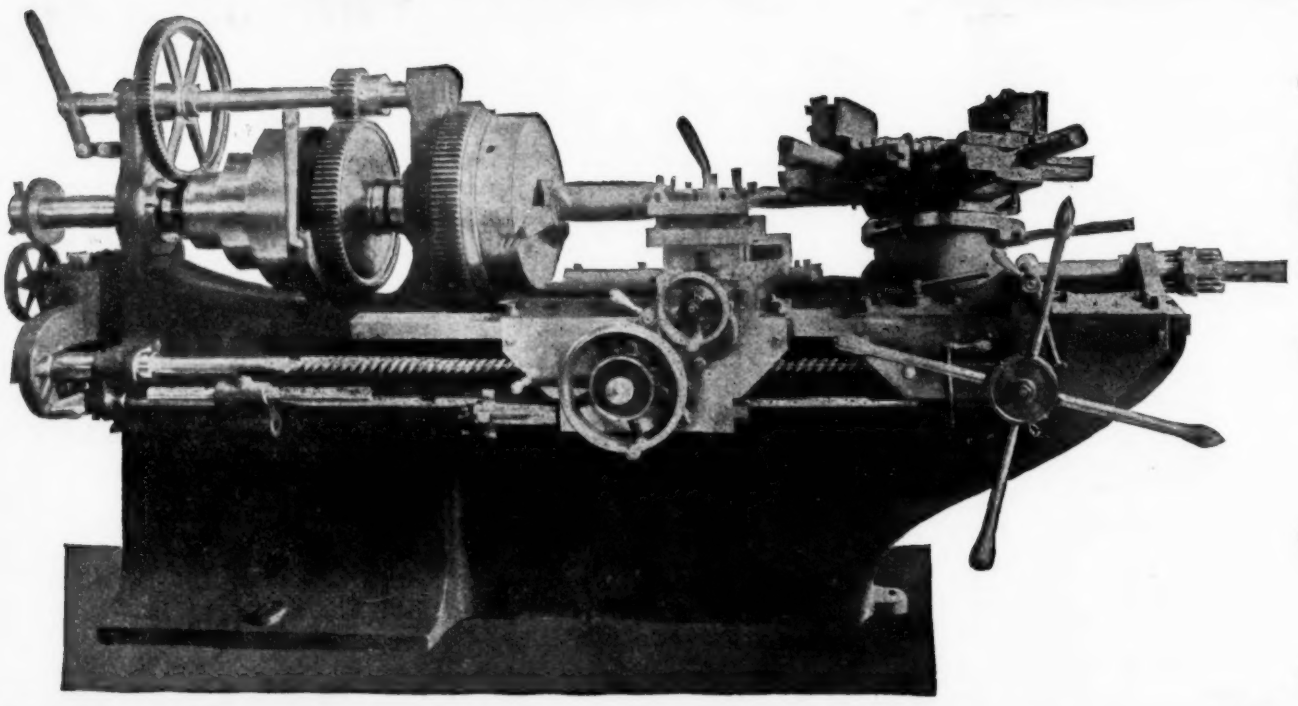
BOLT AND NUT MACHINERY.

COMPLETE EQUIPMENTS A SPECIALTY.
CAR LINK, PIN AND SPIKE MACHINERY,
WASHER MACHINES, WIRE NAIL MACHINES.
SEND FOR CATALOGUE.



THE NATIONAL MACHINERY CO., TIFFIN, OHIO.

TURRET LATHES



REDUCE LABOR COST

Of producing various parts of different machines

50 TO 80 PER CENT.

Description and Prices furnished on application.

We manufacture a large number of Styles and Sizes of

TURRET LATHES

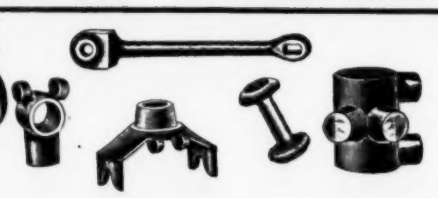
for finishing parts of almost all classes of Machinery.

Also UNIVERSAL TOOL GRINDERS, for Grinding Lathe and Planer Tools.

GISHOLT MACHINE COMPANY, Madison, Wisconsin, U. S. A.

DROP FORGINGS

WYMAN & GORDON
WORCESTER, MASS.



FIRE

in its incipiency can generally be extinguished with a pail of water. Scoring of ENGINE and PUMP piston rods can be prevented by using "EUREKA" PACKING. LOSS of POWER from wrong adjustment of Engine Valve is corrected with an INDICATOR. Ours at $40 is equal in every respect to the high-priced ones.

Send for Circular. HINE & ROBERTSON CO., 61 Cortlandt St., N. Y.

16" Lathe with Taper Attachment.

The Flather New Patent Taper Attachment.

Accurate.
Easy and quick to operate.
No backlash or lost motion.
All changes can be made from front of lathe.

THE BEST.

FLATHER & COMPANY, - NASHUA, N. H.

Note These Facts.

To raise the standard of your work is to increase your sales. One of our customers writes us that they have almost doubled their sales by grinding all the bearings on a machine they are making; and another says they are finishing more work on one of our machines than they did formerly with four men on lathes, and far superior. This is significant and proves our claim, that grinding is the only correct and economic way to finish work.

OUR MACHINE WILL DO AS GOOD WORK AND MORE OF IT IN A GIVEN TIME THAN ANY OTHER, WITHOUT THE WATER RUNNING OVER THE FINISHED SURFACES. Any speed of work or traverse of wheel between the extremes can be had instantly, without changing belts. This, together with above from our customers, fully establish our claims. REVERSING POINTS ARE ALWAYS IN SIGHT (OUR LATEST IMPROVEMENT), AND CHANGED INSTANTLY WITHOUT LOOSENING DOGS OR TURNING KNOBS, AND HAS FINE ADJUSTMENT. SEND FOR CATALOGUE.

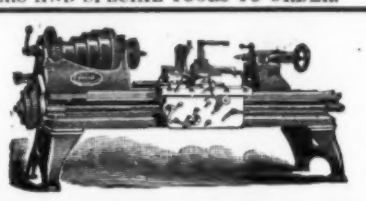
LANDIS BROS., - Waynesboro, Pa.

AGENTS: England: Chas. Churchill & Co., 21 Cross St., Finsbury, London, E. C.
France and Belgium: Ad'Janssens, 16 Place de la Republique, Paris.

MORSE TWIST DRILL AND MACHINE COMPANY,
Manufacturers of Morse Patent Straight-Lip Increase Twist Drills. New Bedford, MASS.

Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.

F. E. REED CO.,
Worcester, Mass.,
MANUFACTURE
ENGINE LATHES
HAND LATHES, FOOT LATHES AND MILLING MACHINES.
Manning, Maxwell & Moore,
Selling Agents, 111 Liberty Street, New York.
60 South Canal Street, Chicago.
424 Telephone Building, Pittsburgh, Pa.



NEW HAVEN MANFG. CO.
NEW HAVEN, CONN.
IRON-WORKING MACHINERY,
Planers, Shapers, Drills, Slotters, Etc.

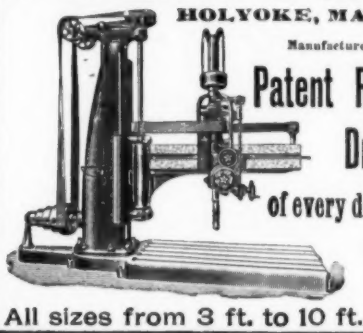
CHAS. A. STRELINGER & CO.,
Tools, Supplies and Machinery,
DETROIT, MICH.

ENGINE LATHES. . . . .
HAND LATHES. . . . . .

Draper Machine Tool Co.
Successor to LATHE & MORSE TOOL CO.
WORCESTER, MASS., U. S. A.

. . . . PLANERS.
. . . . CRANK PLANERS.

C. H. BAUSH & SONS,
HOLYOKE, MASS.
Manufacturers of



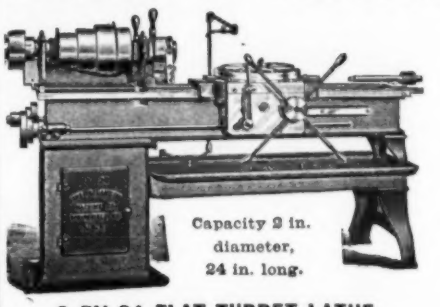
Patent Radial Drills of every description.
All sizes from 3 ft. to 10 ft. arm.

D. SAUNDERS' SONS,
21 ATHERTON ST., Yonkers, N. Y.
MANUFACTURERS OF
Steam & Gas Fitters' Hand Tools.

Pipe Cutting, THREADING, AND Tapping Machines.
SEND FOR CIRCULAR.

THE PATENT WHEEL PIPE CUTTER shown in the cut combines simplicity with strength and lightness. Easily adapted to various sizes of pipe. Rolling instead of sliding motion. No loose parts to become detached and mislaid. All wearing surfaces are of tool steel hardened. Less friction of parts than any other pipe cutter made.

JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VERMONT.



Capacity 2 in. diameter, 24 in. long.
2 BY 24 FLAT TURRET LATHE.

Sole builders of the Flat Turret Lathe, also builders of other Turret Machinery. Publishers of "Rapid Lathe Work," by new method (Hartness System). Send for catalogue.

STEAM ENGINEERING
(Stationary, Locomotive or Marine); Mechanics; Mechanical Drawing; Electricity; Architecture; Architectural Drawing and Designing; Masonry; Carpentry and Joinery; Ornamental and Structural Iron Work; Railroad Engineering; Bridge Engineering; Municipal Engineering; Plumbing and Heating; Coal and Metal Mining; Prospecting; and the English Branches.

The courses commence with addition in Arithmetic, so that to enroll it is only necessary to know how to read and write. A Scholarship entitles the holder to tuition, until he is qualified to receive the Diploma, no matter how long it may take nor how often it may be necessary to review. Students can interrupt their studies and change their residences. Scholarships are not forfeited upon failure to pay installments promptly. Until further notice experimental apparatus will be furnished *free of charge* to students. Students make rapid progress in learning to Draw and Letter. Specially prepared Instruction and Question Papers, Condensed, Simplified.

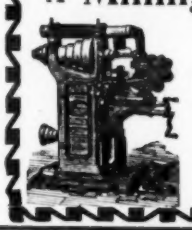
The Steam Engineering course is intended to qualify engineers to secure Licenses. All representations may be relied upon.

Send for Free Circular, stating the subject you wish to study, to

The International Correspondence Schools, SCRANTON, PA.

TAUGHT BY MAIL
THOROUGH PRACTICAL
TRADE MARK REGISTERED.

A Milling Machine or . . . .
a Cutter and Tool Grinder.



If you need either, and where is the shop that doesn't? write
The Cincinnati Milling Machine Co.,
Cincinnati, Ohio.

SENSITIVE DRILLS.
COPYRIGHTED TRADE-MARK.
Do you know that we make the largest, the best, line of Hand, Foot, and Automatic Feed Drills for ½-inch holes and less. Endless belts. Short belts discarded. Patented Improvements. No belt tension on spindles. 1, 2, 3, 4, or more spindles. Investigate. Read up. 84-page Catalogue free.
DWIGHT SLATE MACHINE CO.,
HARTFORD, CONN.

Stover Power Hack Saw and Friction Drills.

Saws made in two sizes Nos. 1 and 2. Cut 4½ to 8 inches. Send for circulars to
STOVER NOVELTY WORKS
Mfgrs. of Wood and Iron-Working Machinery
Special Machinery to order.
23 River St., FREEPORT, ILL., U. S. A.
C. W. BURTON, London, Eng.

BOSTON GEAR WORKS
Frank Burgess, Prop., 35 Hartford St., Boston, Mass.
Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large.
Send for Catalogue. 1,100 sizes of Gears.

J. T. SLOCUMB & CO.,
PROVIDENCE, R. I. U. S. A.

COMBINED DRILL AND COUNTERSINK
FOR CENTERING LATHE WORK.

"PRACTICAL DRAWING."
By J. G. A. MEYER.

The demand for back numbers of the **American Machinist**, containing this valuable series of articles, has been so great, that notwithstanding it has compelled us to issue special reprints of several of the articles, our stock is now limited to complete sets with the exception of two or three issues, and orders can hereafter be filled **by the set only.**

A number of engineering schools are using these articles in lieu of a text book on this important branch of mechanics.

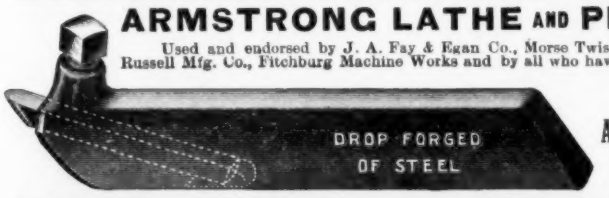
The set of 92 papers will be sent by mail to any address in the U.S., Canada or Mexico for $5.00, postpaid, and to any foreign country for $7.00.

Order now before our stock of papers is exhausted.

ADDRESS:
American Machinist,
203 BROADWAY,
NEW YORK.

BRAINARD MILLING MACHINE CO.
156 Oliver St., Boston, Mass. Works at Hyde Park, Mass.
Milling and Gear-Cutting Machines,
Universal, Tool-Room, Plain and Special Milling Machines; also Gear and Cam-Cutting and Mill-Grinding Machines.
50 Different SIZES and STYLES. Cuts and Prices on Application.

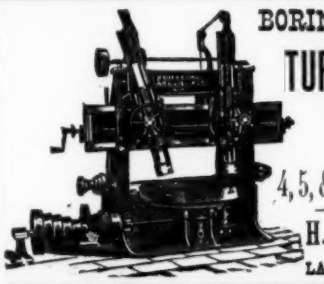
ARMSTRONG LATHE AND PLANER TOOL.
Used and endorsed by J. A. Fay & Egan Co., Morse Twist Drill and Machine Co., Wiley & Russell Mfg. Co., Fitchburg Machine Works and by all who have given it a trial.



Send for circular and prices.
MFG. ONLY BY
Armstrong Bros. Tool Co.,
76 EDGEWOOD AVE.,
CHICAGO.

OUR NEW TOOL BLOCKS ARE GREAT! HAVE YOU SEEN THEM?
CUTTING-OFF MACHINES.
HURLBUT ROGERS MACH. CO., 80. SUDBURY, MASS.

BORING AND TURNING MILLS,
4, 5, & 6 ft. Swing



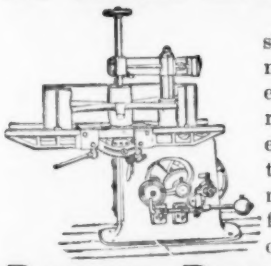
H. Bickford,
LAKEPORT, N. H.

W. D. FORBES & CO.,
ENGINEERS,
1300 HUDSON STREET, HOBOKEN, N. J.

BINDING POSTS, CONTACT BUTTONS AND ALL ELECTRICAL MACHINE WORK.
(TWO BLOCKS FROM 14TH ST. FERRY.)

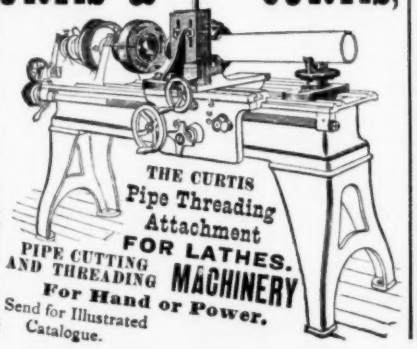
FINE MACHINE WORK, LIGHT FORGING, DRAUGHTING AND DESIGNING.

THE COLBURN KEYWAY CUTTER.



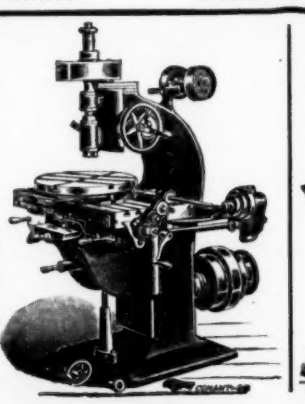
Built in four sizes. Combines many points of excellence. For rapid work and exact duplication of same it has no equal. Send for illustrated catalogue.
BAKER BROTHERS,
365 S. Erie St., TOLEDO, OHIO.

CURTIS & CURTIS,
66 Garden St., Bridgeport, Ct.

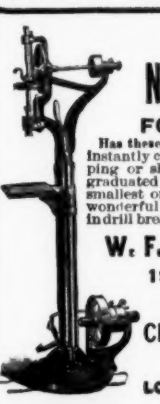


THE CURTIS Pipe Threading Attachment FOR LATHES.
PIPE CUTTING AND THREADING MACHINERY For Hand or Power.
Send for Illustrated Catalogue.

THE BECKER MILLER No. 4
MANUFACTURED BY
JOHN BECKER MANUFACTURING CO.,
FITCHBURG, MASS.
ENGLAND—CHAS. CHURCHILL & CO. Ltd., 21 Cross St., Finsbury, London, E. C.

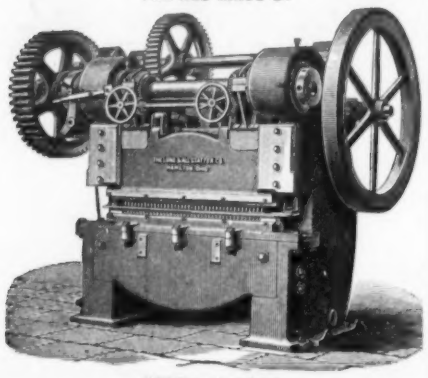


BARNES' New Friction Disk Drill
FOR LIGHT WORK.
Has these Great Advantages: The speed can be instantly changed from 0 to 1600 without stopping or shifting belts. Power applied can be graduated to drive with equal safety the smallest or largest drills within its range—a wonderful economy in time and great saving in drill breakage. Send for catalogue.



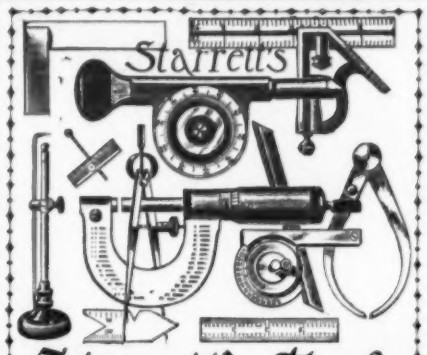
W. F. & JNO. BARNES CO.,
1995 RUBY ST., ROCKFORD, ILL.
ENGLISH AGENTS,
CHAS. CHURCHILL & CO., Ltd.
21 CROSS ST. FINSBURY,
LONDON, E. C., ENGLAND.

The LONG & ALLSTATTER CO.,
HAMILTON, OHIO,
Multiple Punches and Gate Shears
FOR ALL KINDS OF



MULTIPLE PUNCH.

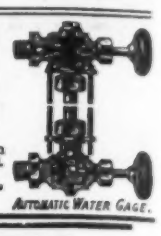
BOILER, TANK AND STRUCTURAL IRON WORK, ROLLING MILLS, LOCOMOTIVE SHOPS, CAR AND WAGON WORKS, PLOW SHOPS, &c., &c.



Starrett's Tools
ARE WARRANTED SATISFACTORY.
SEND FOR CATALOGUE.
L. S. STARRETT, ATHOL, MASS., U. S. A.

W. C. YOUNG MFG. CO., WORCESTER MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.

—THE—
PENBERTHY
SPECIALTIES.
FOR THE BOILER AND ENGINE. ARE THE ENGINEERS' FAVORITES.
$5,000 PENBERTHY AUTOMATIC INJECTORS in use, giving perfect satisfaction under all conditions. Our Jet Pumps, Water Gages and Oil Cups are Unequalled.
SEND FOR CATALOGUE. PENBERTHY INJECTOR CO. DETROIT, MICH.
BRANCH FACTORY AT WINDSOR, ONT.

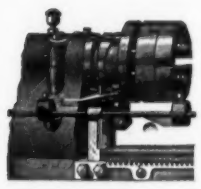


LUNKEN HOSE GATES.

The best and most practical Hose Gate on the market. SIMPLE, COMPACT, DURABLE, **LOW PRICED.** ¾-inch to 3 inches, with and without finished cap and chain. ACCEPTED BY THE INSPECTION DEPARTMENT OF THE ASSOCIATED FACTORY MUTUAL INSURANCE COMPANIES. **It will pay you to investigate this Valve. Write for prices and sample.** SATISFACTION GUARANTEED. Catalogue of numerous "up to date" Steam Specialties, gratis upon request.

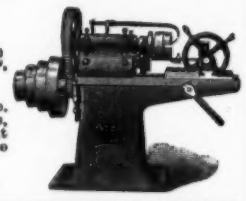
THE LUNKENHEIMER COMPANY.
FACTORIES — CINCINNATI, O.
NEW YORK STORE, 51 JOHN ST.
EUROPEAN STORE, THE LUNKEN VALVE CO. 35 & 37 DOVER ST. LONDON S. E.

DETRICK & HARVEY MACHINE CO.,
BALTIMORE, MD.
MANUFACTURERS OF THE
ADAMS
Automatic Bolt-Threading and Nut-Tapping Machine,
Made in all Sizes to Cut from 1-4" to 6".



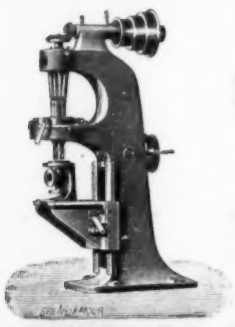
The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list.

Manufacturers of The Open Side Iron Planer.



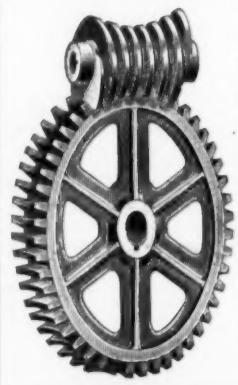
P. BLAISDELL & CO.,
MANUFACTURERS OF

MACHINISTS' TOOLS,
WORCESTER, MASS.
SEND FOR CATALOGUE. MENTION THIS PAPER.



AMERICAN PATENT OF
PHŒNIX
MULTIPLE DRILLS.
For sale or license.
Good profits.
The Düsseldorf Tool & Foundry Co.
Habersang & Zinzen,
DÜSSELDORF, GERMANY.

Albro Worm and Worm Gear



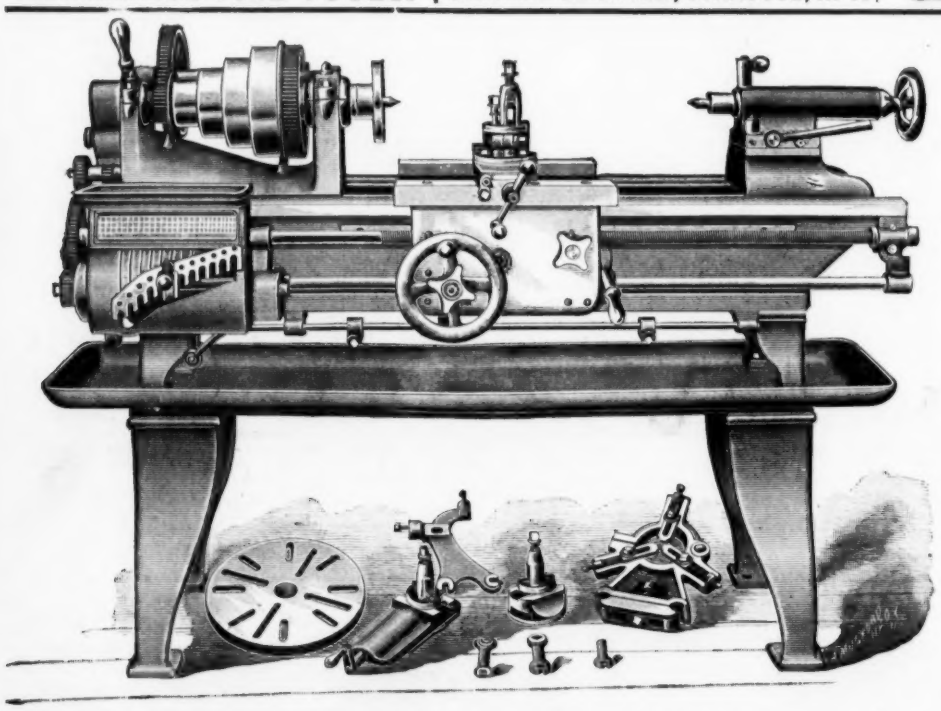
Consumes less power and gives better results than any other System. Information cheerfully furnished.

The Albro-Clem Elevator Co.,
411 & 413 Cherry St.,
Philadelphia, Pa.

3-INCH UNIVERSAL BEVEL.
MAILED TILL JULY 1ST FOR $1.00.
CATALOG FREE.

STANDARD TOOL CO.,
ATHOL, MASS., U. S. A.
MANUFACTURERS OF
MECHANICS FINE TOOLS.

MACHINISTS' SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

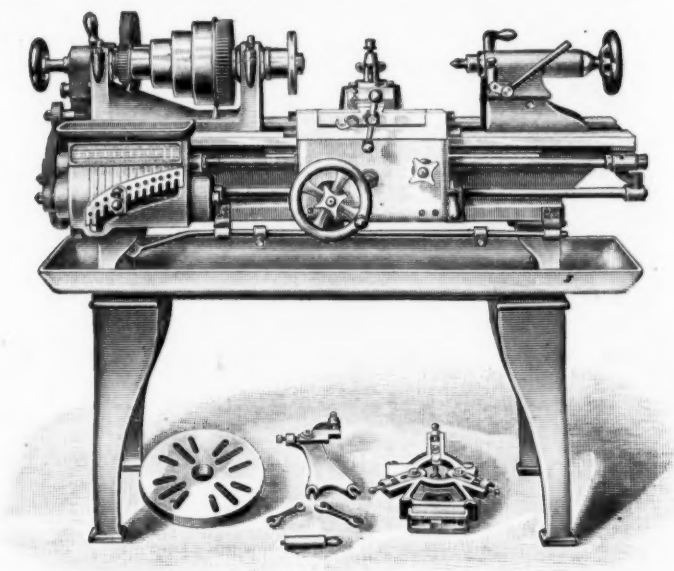


14 in. x 6 ft. Hendey-Norton Lathe and 12 in. x 4 ft. Hendey-Norton Lathe.

These are modern, high grade, practical tools, and are especially adapted for tool-room work.

They have the Norton attachment for screw cutting, giving 36 different threads and 36 different feeds with only two changes of gear, and movement of lever in gear box from one notch to the other.

Note the automatic stop under apron. It will automatically stop carriage at any desired point in either direction. Invaluable for internal or duplicate work.



The 12 in. lathe is fitted with drawing-in sleeve and American Watch Tool Co's. Standard Chuck, used in making small taps, reamers, etc.

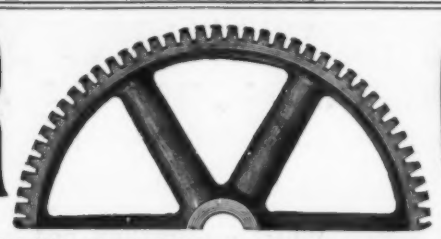
Work finished first and cut from bar afterward. No centering required.

See carriage reverse lever by right-hand side of apron; no reaching for counter-shaft shipper required. Send for catalogue.

THE HENDEY MACHINE CO., Torrington, Conn.

EUROPEAN AGENTS: CHAS. CHURCHILL & CO., LONDON, ENG.
SCHUCHARDT & SCHUTTE, BERLIN, GERMANY.
EUGEN SOLLER, BASEL, SWITZERLAND.

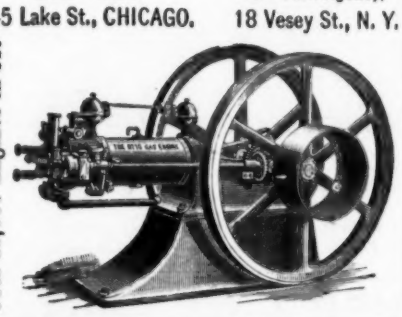
GEARS CUTTING



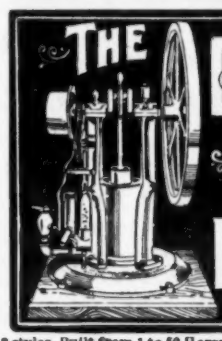
LELAND, FAULCONER & NORTON CO. Detroit, Mich.

"THE OTTO" GAS ENGINE WORKS,
33d and Walnut Sts., PHILADELPHIA.
Branch Office, 245 Lake St., CHICAGO.
New York Agency, 18 Vesey St., N. Y.

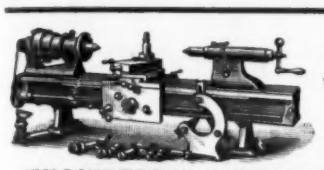
Over 40,000 Engines in Use



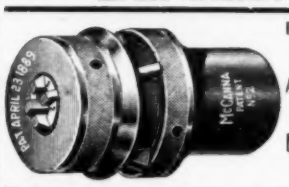
THE BACKUS GAS ENGINE



2 styles, Built from 1 to 50 Horse Power. Send for Circular.
BACKUS WATER MOTOR CO., Newark, N.J.
Also Mfrs. VENTILATING FANS.



— FOR —
Bicycle WATCH-WORK OR TOOL ROOM.
ENGINEERING APPLIANCE CO.
JAMESTOWN, N. Y.



IT CUTS COSTS.
The McCanna Adj. Thread Cutting and Milling Tool.
Made only by
The Taylor-Rice Engineering Co., Wilmington, Del., U.S.A.

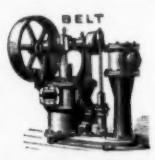
Place your LIGHT RIGHT where you want it.

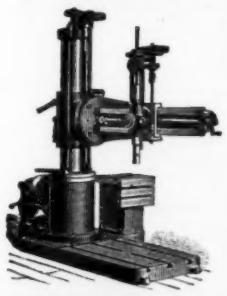
Farles' Patent UNIVERSAL LAMP HOLDER.
Several styles and sizes. Ask your dealer for them or write direct to FARIES MANUF'G CO., Decatur, Ill.
Catalogue free.

KEUFFEL & ESSER CO.
NEW YORK.
Branches: 111 Madison St., Chicago. 708 Locust St., St. Louis.
DRAWING MATERIALS AND Surveying Instruments.
The largest and best assorted stock in America. All requisites for field and draughting room. We have made a study of this line, and our goods are warranted to be as nearly perfect as it is possible to make them. Prices reasonable.
CATALOGUE ON APPLICATION.

LATEST! BEST! CHEAPEST!
COLD METAL SAWING MACHINES.
FOR ALL CLASSES OF WORK.
EVERY MACHINE WARRANTED.
SEND FOR NEW CATALOGUE.
THE Q AND C
CHICAGO, ILL., - - 703-7 WESTERN UNION BLDG.
NEW YORK, - - - - 29 BROADWAY.

IN STOCK CONOVER'S HANDSOME CATALOGUE ON CONDENSERS
THE CONOVER MFG. CO. 39 CORTLANDT ST. N.Y.





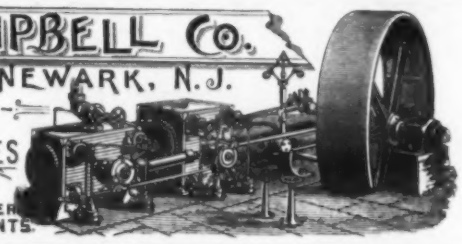
OUR LATEST PRODUCTION.
No. o Radial Drill. Something entirely new. Advantages for all shops. Now ready for you.
BICKFORD DRILL AND TOOL CO.,
3 Pike Street, Cincinnati, Ohio.

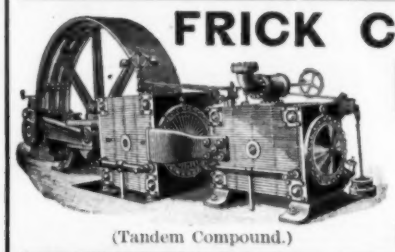
DRY STEAM.
Simpson's Centrifugal Steam Separator.
For Supplying Clean and Dry Steam to Engines, Dry Houses, etc.
Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require; also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.
KEYSTONE ENGINE & MACHINE WORKS,
Fifth and Buttonwood Streets, Philadelphia.
THOMAS HOEY, 147 Sumner St., E. Boston, Mass., Agent.
JAS. BEGGS & CO., 9 Dey St., New York, Agents.

MOFFET PORTABLE DRILL.
UNSURPASSED AS A REAMER.
Will work in any position.

Weighs 42 lbs. and drills from ¾ to 2 inches diameter.
Runs with Steam —OR— Compressed Air.
Send for Circular.
Manufactured by J. G. TIMOLAT, 89 & 91 S. Fifth Ave., NEW YORK.

THE WATTS, CAMPBELL CO.
MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.
NEWARK, N.J.
CONTRACTS TAKEN FOR COMPLETE POWER PLANTS.

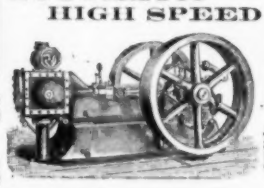




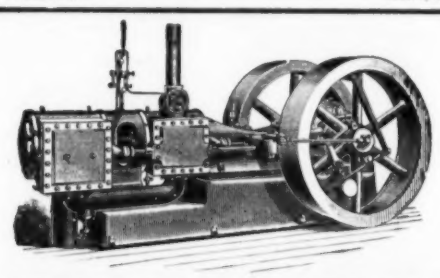
(Tandem Compound.)

FRICK COMPANY, WAYNESBORO, PA.
ECLIPSE CORLISS ENGINES,
40 TO 2,000 H. P., ALL STYLES.
Send for Illustrated Catalogue.
ALSO BUILDERS OF
Electric High Speed Engines and Ice-Making and Refrigerating Machinery.

WESTON AUTOMATIC HIGH SPEED ENGINES
HIGH PRESSURE BOILERS AND COMPLETE POWER PLANTS

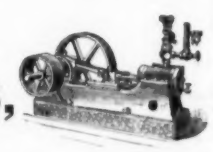


WESTON ENGINE CO., Painted Post, N.Y.
REPRESENTATIVES.
Julian Scholl & Co., 136 Liberty St., N. Y. City.
Scranton Supply & Machinery Co., Scranton, Pa.
Hoffman-Russell Co., 82 Lake St., Chicago, Ill.
Thos. K. Carey & Bros. Co., 26 Light St., Baltimore, Md.



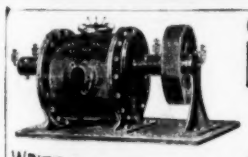
AMES IRON WORKS, OSWEGO, N. Y.
38 Cortlandt St., New York City.
18 South Canal St., Chicago, Ill.
50 Oliver St., Boston, Mass.
1026 Filbert St., Philadelphia, Pa.

ORR & SEMBOWER,
(INCORPORATED.)
VERTICAL, HORIZONTAL, MARINE —AND— HOISTING ENGINES,
VERTICAL AND HORIZONTAL BOILERS.
READING, PA.
WESTERN BRANCH, 60 S. CANAL STREET, CHICAGO.



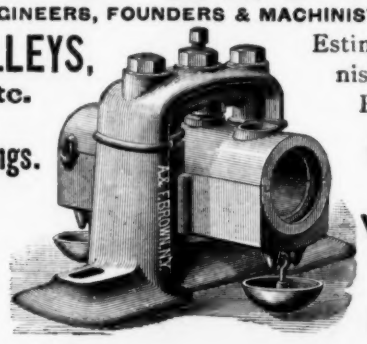
One Quality. One Price.

"EXCELSIOR" VALVES.
THE BEST.
Specially Designed for High Steam Pressure.
ADVANTAGES:
Can be Re-packed Under Any Pressure. Has Self-Locking Packing Nut. Can be Re-ground in Place.
THE KELLY & JONES CO.,
104 JOHN STREET, NEW YORK.
Write for Descriptive Circular.



GARDEN CITY POSITIVE PRESSURE BLOWER
NO GEARS
SAVES 10 TO 15% IN POWER
SIMPLE — POSITIVE — EFFICIENT
WRITE FOR CATALOGUE.
GARDEN CITY FAN CO. CHICAGO, ILL. U.S.A.

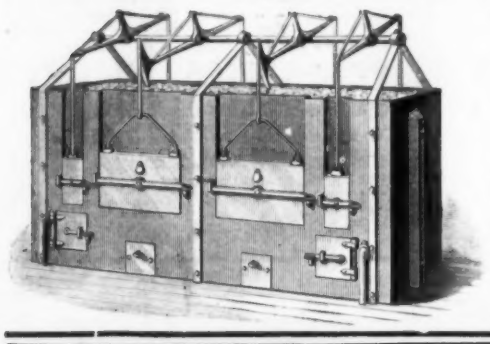
A. & F. BROWN,
ENGINEERS, FOUNDERS & MACHINISTS.
SHAFTING, PULLEYS, HANGERS, Etc.
Friction Clutch Couplings.
STEAM SIRENS, [WHISTLES].
Send for Catalogue.
17 Dey St., New York.



Estimates and Plans furnished for transmitting Power by HORIZONTAL AND VERTICAL SHAFTING.
Also for Erecting same.

BROWN & SHARPE MFG. CO.,
PROVIDENCE, R. I.

CASE-HARDENING FURNACES.
EQUALLY ADAPTED FOR ANNEALING. TWO SIZES.



Large Case-Hardening Furnace.
4 ft. 3 in. x 2 ft. 3 in. x 1 ft. 1 in.

Small Case-Hardening Furnace.
3 ft. x 1 ft. 6 in. x 10 in.

Especially adapted for Screw and Nut Work, Bicycle, Sewing Machine, Gun Parts, etc. Send for circular.

ENGLAND—BUCK & HICKMAN, 280 Whitechapel Road, London, E.
ENGLAND—CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, E. C.
GERMANY—G. DIECHMANN, Ansbacherstr 5 Berlin, W. 62.
FRANCE—FENWICK FRERES & CO., 21 Rue Martel, Paris.
FRANCE—F. G. KREUTZBERGER, 140 Rue de Neuilly Puteaux (Seine.)
CHICAGO, ILL.—FRED. A. RICH, 23 So. Canal St.
NEW YORK CITY—F. G. KRETSCHMER, 136 Liberty St., Room 503.

COMPLETE LABOR-SAVING EQUIPMENTS.

MACHINE TOOLS.

Correspondence Solicited. PITTSBURGH, PHILADELPHIA, CHICAGO, NEW YORK, BOSTON,

NO. 2 HYDROSTATIC PRESS.

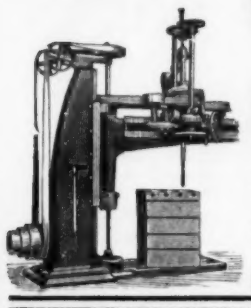
THE **NILES TOOL WORKS** CO., HAMILTON, OHIO.

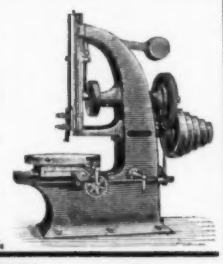
THE ORIGINAL UNVULCANIZED PACKING.

Jenkins Standard Packing has been severely tested in all positions and under all actions of steam, superheated steam, oils, acids, etc., and has never failed to make a perfect joint when properly applied. See that it is stamped "Jenkins Standard Packing" and bears Trade Mark.

JENKINS BROS., New York, Boston, Philadelphia, Chicago.

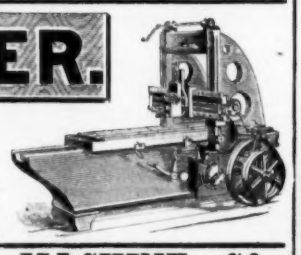
WM. SELLERS & CO., Incorporated,
PHILADELPHIA, PA.
MANUFACTURERS OF
MACHINE TOOLS,
TRAVELING CRANES AND SWING CRANES,
Operated by Electricity, Shafts or Independent Engines.
Turn Tables, Testing Machines, Shafting, Pulleys, Hangings, Couplings, etc.
INJECTORS FOR ALL CLASSES OF BOILERS.



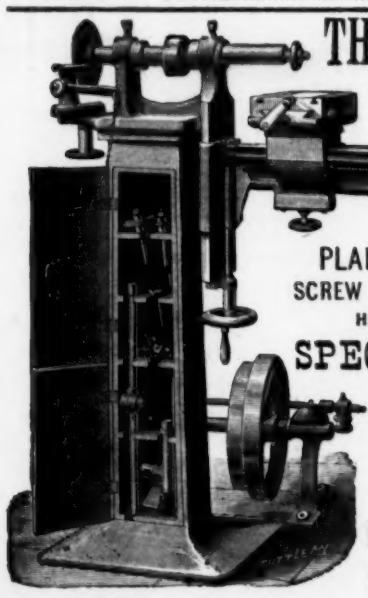


THE GRAY PLANER.
Manufactured by
THE G. A. GRAY CO.,
CINCINNATI, OHIO.

THE FOLLOWING MACHINERY MERCHANTS CARRY SAMPLES.
J. A. Fay & Egan Co.....24 South Canal Street, Chicago.
Strong, Carlile & Turney Co....193 Bank Street, Cleveland.
E. A. Kinsey & Co.....227 West 4th Street, Cincinnati.
Thos. K. Carey & Bros. Co.....26 Light Street, Baltimore.
J. J. McCabe.....14 Dey Street, New York City.



THE GARVIN MACHINE CO.,
MANUFACTURERS OF
UNIVERSAL
Cutter and Tool Grinders,
PLAIN AND UNIVERSAL MILLING MACHINES,
SCREW MACHINES, TAPPING MACHINES, GEAR CUTTERS,
HAND LATHES, DRILL PRESSES, SPRING COILERS, ETC.
SPECIAL BICYCLE MACHINERY.
ALSO DEALERS IN
METAL WORKING MACHINERY
OF ALL KINDS.
Over 600 Various Machine Tools for Immediate Delivery.
Laight and Canal Streets, - New York.
Also 51 N. 7th St., - Philadelphia, Pa.



PRATT & WHITNEY CO.,
HARTFORD, CONN., U. S. A.

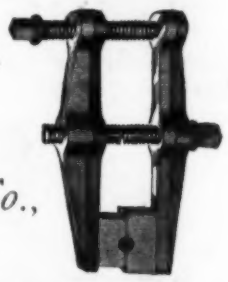
Solicit orders for the following machines and appliances for the manufacture of bicycles:

Turret head machines and patented tools for forming hubs from the bar or forgings. Adjustable multi-spindle machines for drilling spoke holes in hubs and rims. Wheel constructing and adjusting tables, sprocket wheel boring and facing machines, tube cutting machines, fork head threading machines, nipple tapping machines, Tucker's open dies, revolving chucks.

C AND MACHINISTS' CLAMPS.

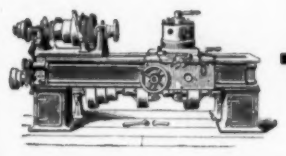
C Clamps, in 5 Sizes, with Openings
1¼, 2¼, 3¼, 4½, 6½ *inches.*

Machinists' Clamps, in 4 Sizes, with Openings
1¼, 2¼, 3¼, 4¼ *inches.*

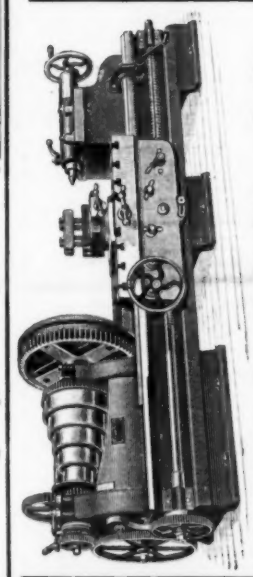


The Billings & Spencer Co.,
Hartford, Conn., U. S. A.
Chicago Office: 17 S. CANAL STREET.

England—CHARLES CHURCHILL & CO., 23 Cross St., Finsbury, London, E. C.
France—L. ROFFO, 58 Boulevarde Richard Lenoir, Paris. *Russia—J. BLOCK, Moscow.*



WARNER & SWASEY,
CLEVELAND, OHIO.
MANUFACTURERS OF
TURRET ENGINE LATHES.
IRON AND BRASS WORKING MACHINERY.
SEND FOR ILLUSTRATED CATALOGUE.

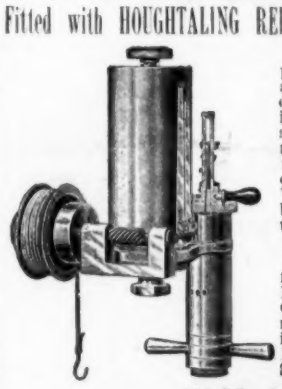


FIFIELD TOOL CO.,
MANUFACTURERS OF
ENGINE LATHES
from 17 to 64 in. swing. Cuts, Photographs and Prices furnished on application.
LOWELL, MASS., U. S. A.

UPRIGHT DRILLS,
CUTTING-OFF MACHINES,
KEY-SEATING MACHINES
AND
SPECIAL MACHINERY.
Write for Catalogue and Prices.
THE W. P. DAVIS MACHINE CO.,
ROCHESTER, N. Y.

WYMAN & GORDON
WORCESTER, MASS.
DROP FORGINGS
— WOOD WORKERS' VISES —

The Ashcroft Manufacturing Co.,
SOLE MANUFACTURERS OF
The Tabor Steam Engine Indicator,
Fitted with HOUGHTALING REDUCING MOTION.



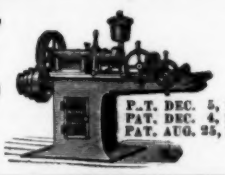
The most Complete, Compact, and Reliable Indicator Outfit, for indicating high or slow speed engines now made. This instrument received at "The World's Columbian Exposition" the
Highest Award
for Excellence of Design, Superior Grade of Workmanship and Finish, Reliability and Efficiency. Send for Special Pamphlet.

Office and Salesroom, 111 Liberty St., New York.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.
HARTFORD, CONN.

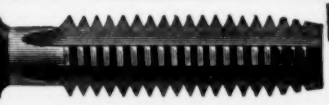
J. M. ALLEN, PRESIDENT.
WM. B. FRANKLIN, VICE-PRESIDENT.
F. B. ALLEN, SECOND VICE-PRESIDENT.
J. B. PIERCE, SECRETARY & TREASURER.

THE ACME MACHINERY CO.,
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single and Double Automatic
BOLT CUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.



We make the following sizes of
HENDEY-NORTON LATHES,
12″, 14″, 16″, 18″, 20″, 24″, 27″ and 30″ swing. Also
IMPROVED HENDEY PILLAR SHAPERS,
15″, 24″ and 25″ stroke.
See our advertisement on page 498 of this paper.
THE HENDEY MACHINE CO., Torrington, - Conn.

J. M. CARPENTER
PAWTUCKET, R. I.



Manufacturer —of— TAPS & DIES